LAND / WILDLIFE INTEGRATION

INTÉGRATION TERRE / FAUNE

Ecological Land Classification Series,
No. 11

Série de la classification écologique du territoire,
N° 11

LAND/WILDLIFE INTEGRATION

INTÉGRATION TERRE/FAUNE

Proceedings of a technical workshop to discuss the incorporation of wildlife information into ecological land surveys

Compte rendu d'un atelier technique sur l'introduction de l'information sur la faune dans les relevés écologiques du territoire

1 and 2 May 1979
Saskatoon, Saskatchewan

1 et 2 mai 1979
Saskatoon, Saskatchewan

Compiled and Edited by
D. G. Taylor

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D. G. Taylor

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Lands Directorate
Environment Canada

Direction générale des terres
Environnement Canada

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PREFACE

Of Canada's land resources, wildlife is often an integral component. Recent concern over the impact of developments in the north on caribou herd, waterfowl, and marine mammals is just one illustration of the social and economic significance of wildlife to Canadians. Many of these impacts of development are related to their effects on wildlife habitat and on the role wildlife plays in the ecosystem itself. The information needed to assess these impacts can often be derived from an ecological land survey; an holistic, environmental baseline study which allows for various assessments of land uses.

The importance of wildlife data in ecological land surveys has not been fully recognized nationally. However, on a regional basis, its inclusion in resource surveys has frequently been routine. At this workshop, a diverse group of environmental scientists examined the studies to date in an attempt to develop a rationale and methodology for incorporating wildlife data. The various papers presented provided a comprehensive overview of recent attempts to achieve this goal in a wide range of environments. Hopefully, the experiences and ideas presented here will both stimulate further discussion and provide a guide for those working with integrated resource surveys.

PRÉFACE

La faune est souvent partie intégrante des ressources du Canada en terres. Les récentes préoccupations au sujet des répercussions de l'exploitation du Nord sur les hardes de caribous, les oiseaux aquatiques et les mammifefes marins ne sont qu'une illustration de l'importance sociale et économique de la faune ax yeux des Canadiens. Une grande partie des conséquences de l'exploitation se rapportent a l'habitat faunique et au rôle joué par la faune dans l'écosysteme. Il est souvent possible d'obtenir les renseignemnets nécessaires a l'évaluation de ces conséquences a partir d'un relevé écologique des terres, étude de base globaliste dur l'environnement que permet diverses évaluations de l'utilisation des terres.

L'importance des sonnées sur la faune dans les relevés écologiques des terres n'est pas tout a fait reconnue a l'echelle nationale. Toutefois, dans les régions, son inclusion dans les relevés des ressources se fait souvent de façon courante. Au cours de l'atelier, un groupe de spécialistes en sciences environnementales on examiné les études réalisées jusqu'a maintenant, pour essayer de justifier l'incorporation des données sur la faune et de trouver des méthodes a cet effet. Les divers documents présentés ont donné un aperçu exhaustif des dernieres tentatives faites en ce sens dans un large éventail d'environnements. Les expériences et les idées présentées ici devraient stimuler la discussion et servir de guide a ceux qui travaillent a l'aide de relevés intégrés des ressources.

OPENING REMARKS

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BACKGROUND AND RATIONALE

Ecological Land Survey (ELS) is an integrated, holistic approach to land survey by which areas of land, as ecosystems, are classified according to their ecological unity. The classification process of an ELS includes the description and synthesis of data related to the biological and physical characteristics of the land. As such, wildlife data should be part of the data base.

The lack of adequate wildlife data and information in land survey data bases has long been recognized. However, only recently have concerted efforts been made to include the wildlife component. These studies provide a foundation for evaluating the methodologies of and problems associated with incorporating wildlife data into ecological land surveys.

Discussions with wildlife specialists and others concerned with the development and application of the ELS approach have clearly showed the need for a formal meeting to focus on the wildlife component of ELS. As a result, the Canada Committee on Ecological (Biophysical) Land Classification undertook to sponsor and organize this LAND/WILDLIFE INTEGRATION WORKSHOP.

OBJECTIVES

This workshop aimed at:

- assembling those concerned with the integration of wildlife information into ecological and surveys to exchange ideas and experiences;

- discussing recent attempts at including wildlife data and information into ELS bases; and

- generating ideas and recommendations, based on experience to-date, on how to effectively incorporate wildlife data and information into land data bases.

ALLOCUTION D'OUVERTURE

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ÉTAT DE LA QUESTION ET RAISON D'ÊTRE

Le Relevé écologique du territoire (RET) consiste en une méthode intégrée et globaliste de relevé du territoire qui permet de classer des régions, en tant qu'écosystèmes, selon leur unité écologique. Le processus de classification d'un RET comprend la description et la synthèse de données portant sur les caractéristiques biologiques et physiques du territoire. Par conséquent, la base de données devrait intégrer les données sur la faune.

On sait depuis longtemps qu'il manque de données et d'information appropriées sur la faune dans les bases données concernant les relevés du territoire. Toutefois, les efforts concertés en vue d'y incorporer l'aspect faune sont très récents. Ces études permettent d'évaluer les méthodes et les problèmes de l'intégration des données sur la faune dans les relevés écologiques du territoire.

Suite à des discussions avec des spécialistes en matière de faune et d'autres personnes intéressées à l'élaboration et à l'application de l'approche du RET, il s'est révélé nécessaire de convoquer une réunion officielle pour se pencher sur l'aspect faune des RET. En conséquence, le Comité canadien de la classification écologique du territoire a décidé de parrainer et d'organiser l'ATELIER CONCERNANT L'INTEGRATION TERRES-FAUNE.

OBJECTIFS

Cet atelier visait:

- à réunir les personnes intéressées à l'intégration de l'information faunique dans les relevés écologiques du territoire, en vue d'un échange d'idées et d'expériences;

- à traiter des récentes tentatives d'introduction de données et de renseignements sur la faune dans les bases des RET; et

- à présenter des idées et des recommandations,

RESULTS

These 'proceedings' summarize the recent experiences of those attempting to include wildlife data and information into ecological land surveys. These experiences and the recommendations generated by the workshop participants will assist in developing effective methodologies for incorporating wildlife data into ecological land surveys. Furthermore, this meeting will provide the basis for wildlife input to a set of revised guidelines for ecological land surveys. This will be another step towards truly ecological Ecological Land Surveys.

d'après l'expérience acquise jusqu'à ce jour, concernant la façon d'incorporer efficacement les données et l'information sur la faune dans les bases de données écologiques.

RÉSULTATS

Ce compte-rendu résume les récentes expériences de ceux qui ont tenté d'incorporer les données et les renseignements relatifs à la faune dans des relevés écologiques de territoire. Ces expériences et les recommandations formulées par les participants à l'atelier aideront à créer des méthodes d'incorporation efficaces. Par ailleurs, cette réunion servira à introduire l'aspect faune dans un ensemble de lignes directrices révisées applicables à un relevé écologique du territoire. On aura alors franchi un pas de plus vers l'exécution de relevés vraiment écologiques du territoire.

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Moderator: N. Novakowski,
Canadian Wildlife Service,
Environment Canada

Président: N. Novakowski,
Service canadien de la faune,
Environnement Canada

THE CANADA COMMITTEE ON ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION (CCELC): HISTORY, OBJECTIVES, ORGANIZATION, AND ACTIVITIES

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HISTORY

A predecessor of the CCELC was the Subcommittee on Bio-physical Land Classification, a subcommittee of the National Committee on Forest Land (NCFL), which was organized in 1966. The Subcommittee served as a forum for the discussion and introduction of new trends in integrated environmental management and integrated survey techniques. It developed the biophysical land classification system and produced guidelines for biophysical land classification (Subcomm. Bio-phys. Land Classif., 1969).

The NCFL and the Subcommittee on Bio-physical Land Classification were dissolved in 1972. This meant that there no longer existed a forum for discussing improvements and modifications on the 1969 guidelines. In the meantime, however, there was still a rapidly growing number of biophysical-type surveys and research carried out for resource management, planning, and environmental purposes by federal, provincial, and private agencies. Thus, there was an obvious requirement for a technical coordination committee, and recommendations to this effect were made at workshops held in Winnipeg and Toronto.

In an attempt to meet these coordination concerns, the Lands Directorate of Environment Canada, in cooperation with other federal and provincial agencies, organized a meeting at which was founded the Canada Committee on Ecological (Biophysical) Land Classification (CCELC). At this meeting, held in May 1976, the objectives, organization, membership, and working groups were decided.

OBJECTIVES

The general objectives of the CCELC are to encourage the continued development and to promote the application of a uniform ecological approach to land classification. These objectives are to be achieved through:

- technical information exchange and organization of problem-oriented working groups and workshops;
- encouragement of the development and wide distribution of information on methodology and procedure of ecological land classification;
- the promotion of discussions with the general public, users, and potential users on the presentation and application of ecological data bases; and
- recommendations and advice to governmental and private agencies on the application, feasibility, methodology, benefits, and costs of ecological land surveys.

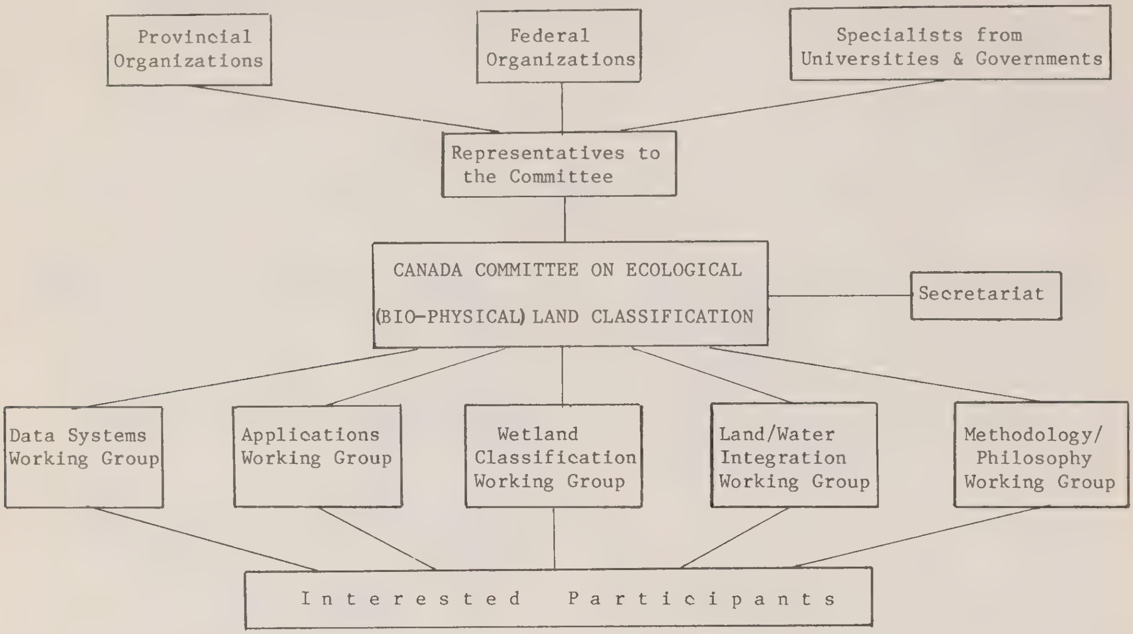
ORGANIZATION

The membership of the CCELC consists of one representative for each province and one for each of the key federal agencies. In addition, specialists from universities, provincial, and federal agencies, and leaders of ecological baseline studies are invited to participate. Currently, the Chairman and Executive Director is J. Thie of Environment Canada.

The overall activities of the CCELC are coordinated through a Secretariat, which is staffed and funded by the Lands Directorate, Environment Canada. Secretariat functions include the editing and publication of CCELC Newsletters, working papers, and reports, along with the organizing and overseeing of CCELC national meetings, projects, and working groups. Voluntary efforts of individuals across Canada also provide necessary input to the functioning of the Committee (Figure 1).

The Committee presently has five working groups: Methodology/ Philosophy; Applications; Data Systems; Wetland Classification; and Land/Water Integration. These groups were formed as a result of specific recommendations of the initial CCELC meeting and are aimed at addressing particular aspects of ecological land classification which either have made significant gains or will require further study.

Figure 1: General organization of the Canada Committee on Ecological (Biophysical) Land Classification.



ACTIVITIES AND PUBLICATIONS

In addition to Working Group activities, the CCELC, since its inception, has sponsored national workshops on Ecological Land Classification in Urban Areas, on Land/Water Integration, and on Wetlands. Also, the CCELC has held two national meetings. The first focussed on the status of Ecological Land Classification in Canada, and the second on the Applications of an ecological data base. Some of these activities are reported among the following list of publications:

Canada Committee on Ecological (Biophysical) Land Classification. 1977. Ecological (Biophysical) Land Classification in Canada: Proc. First Meeting Can. Comm. on Ecol. (Biophys.) Land Classif., 25-28 May 1976, Petawawa, Ont. Ed. by J. Thie and G. Ironside. Ecol. Land Classif. Ser., No. 1, Lands Directorate, Envir. Can., Ottawa. 269p.

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__________. 1979. Applications of Ecological (Biophysical) Land Classification in Canada: Proc. Second Meeting Can. Comm. on Ecol. (Biophys.) Land Classif., 4-7 April 1978, Victoria, B.C. Comp. and Ed. by C.D.A. Rubec. Ecol. Land Classif. Ser., No. 7, Lands Directorate, Envir. Can., Ottawa. 396p.

__________. NEWSLETTERS. Edited by E.B. Wiken and G.R. Ironside.

No. 1: The CCELC: Background, Objectives and Working Groups;
No. 2: A Preliminary Index of Land Surveys in Canada; and Terminology;
No. 3: Chairman's Report;
No. 4: Wildlife Data in Ecological Land Classification;
No. 5: The Vegetation Component in Ecological Land Classification;
No. 6: The Climate Component in Ecological Land Classification; and Terminology.

Land/Water Integration Working Group. 1977. Land/Water Integration: Proceedings of the first meeting, February 1977. Ed. by D. Welch. 70p.

Methodology/Philosophy Working Group. 1977. Revised Working Paper on Methodology/ Philosophy of Ecological Land Classificaton in Canada (comp. and ed. by J.S. Rowe), p.23-30 in: Ecol. Land Classif. Ser., No. 7, Lands Directorate, Envir. Can.

Welch, D. and E. Wiken. 1979. Canada Committee on Ecological Land Classification. Resource Inventory Notes (April): 1-3, Bureau of Land Management, Denver, Co.

Wiken, E.B. and G. Ironside. 1977. The development of ecological (biophysical) land classification in Canada. Landscape Planning 4:273-275.

FUTURE ACTIVITIES

From now until the early 1980's, CCELC activities will focus on user training, land classification workshops, revised guidelines for ecological land surveys, the preparation of an Ecoregion Map of Canada, and the development of methods of handling and applying an ecological data base.

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Wiken, E.B. 1978. The role of national and international coordination in Ecological Land Classification, p. 183-191 in: Integrated inventories of renewable natural resources: Proceedings of the workshop, 8-12 January 1978, Tucson, Arizona. Rocky Mountain Forest and Range Experiment Station General Technical Report RM-55.

LE COMITÉ CANADIEN DE LA CLASSIFICATION ÉCOLOGIQUE DU TERRITOIRE: SON HISTORIQUE, SES OBJECTIFS, SON ORGANISATION ET SES ACTIVITÉS

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HISTORIQUE

Le CCCET fut précédé par le Sous-comité de la classification bio-physique du territoire, lequel relevait du Comité national des terres forestières (CNTF), mit sur pied en 1966. Le sous-comité servait de tribune pour l'analyse et l'adoption des nouvelles tendances en matière de gestion intégrée de l'environnement et de techniques intégrées de relevés. Il mit sur pied le système de classification bio-physique du territoire pour lequel il dressa des directives (Subcommittee on Bio-physical Land Classification, 1969).

En 1972, le CNTF et son sous-comité étaient dissous. Disparaissait ainsi toute tribune de discussions pour améliorer ou modifier les directives de 1969. Entre-temps, toutefois, les recherches et relevés bio-physiques continuaient de se multiplier aux niveaux fédéral, provincial et privé, dans les domaines de la gestion et de la planification des ressources de l'environnement. La création d'un comité de coordination technique était devenue une nécessité évidente, création qui fut recommandée lors d'ateliers tenus à Winnipeg et Toronto. C'est dans ce contexte que la Direction générale des terres d'Environnement Canada, en collaboration avec d'autres organismes fédéraux et provinciaux, organisa en mai 1976 une réunion où l'on mit sur pied le Comité canadien de la classification écologique du territoire (CCCET). On fixa alors les objectifs, l'organisation, la participation et les groupes de travail du nouveau comité.

OBJECTIFS

Les objectifs généraux du CCCET sont d'encourager le développement et l'application uniforme de l'approche écologique en ce qui a trait à la classification du territoire. On compte pour ce faire:

- échanger des informations techniques, et organiser des groupes et ateliers de travail chargés d'étudier les problèmes;

- encourager l'accumulation et la diffusion à grande échelle d'information sur la méthodologie et la procédure de la classification écologique du territoire;

- encourager les discussions avec le grand public, les utilisateurs actuels et potentiels, sur la présentation et l'application des données écologiques de base; et

- présenter des recommandations et fournir des conseils aux organismes gouvernementaux et privés sur l'application, la faisabilité, la méthodologie, les avantages et les coûts des relevés écologiques du territoire.

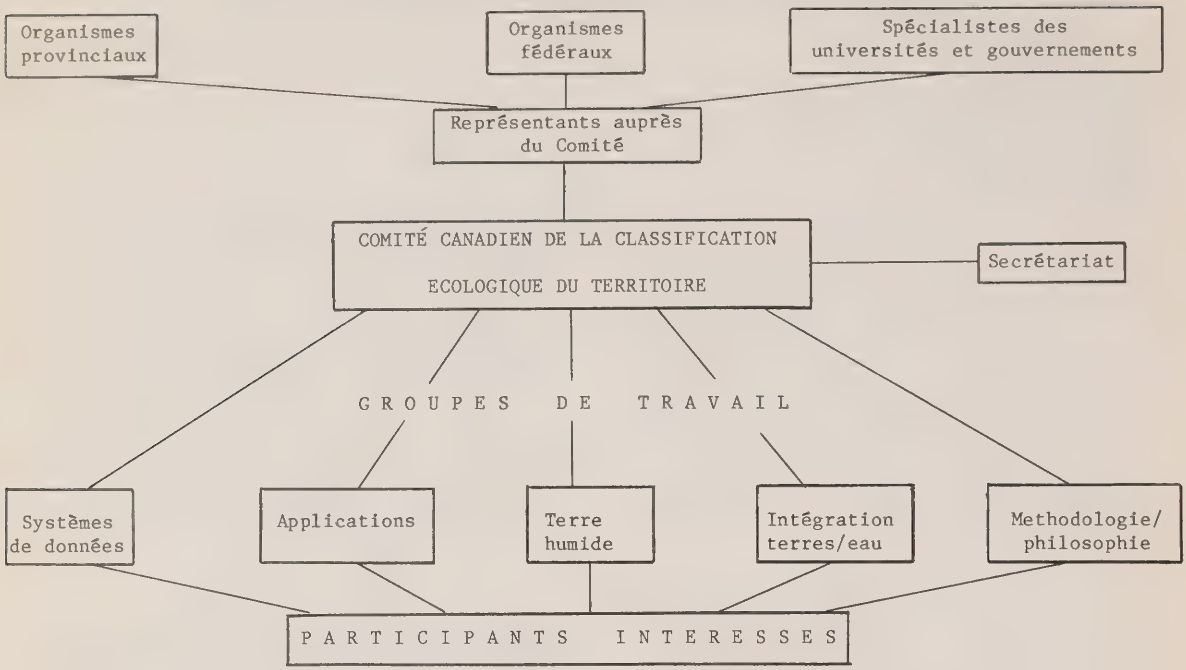
ORGANISATION

Les membres du CCCET se composent d'un représentant de chaque province et de plusieurs organismes fédéraux. De plus, le Comité trouve appui dans la participation des spécialistes des universités, des provinces, des organismes fédéraux, et de responsables d'études écologiques fondamentales. C'est M. J. Thie d'Environnement Canada qui occupe actuellement les postes de président et de directeur général.

Les activités du CCCET sont coordonnées par le biais d'un secrétariat, dont le personnel et les fonds sont fournis par la Direction générale des terres, d'Environnement Canada. Les tâches du secrétariat comprennent la rédaction et la publication des communiqués, documents de travail et rapports du CCCET ainsi que l'organisation et la coordination des réunions nationales du CCCET, des projets et des groupes de travail. Des volontaires de tout le pays fournissent également l'apport nécessaire à la bonne marche du Comité (Figure 1).

Le Comité compte présentement cinq groupes de travail: méthodologie/philosophie; applications; systèmes de données; classification des terres humides; et intégration terres/eau. La formation de ces groupes a fait suite à des recommandations spécifiques de la première réunion du CCCET. Ils se penchent essentiellement sur des aspects particuliers de la classification écologique du territoire où des progrès notables ont été réalisés ou qui exigent des études plus approfondies.

Figure 1: Structure générale de l'organisation du Comité canadien de la classification écologique du territoire (Wiken, 1978).



ACTIVITÉS ET PUBLICATIONS

En plus des activités des groupes de travail, le CCCET a parrainé, depuis ses débuts, des ateliers nationaux sur la classification écologique du territoire dans les secteurs urbains, sur l'intégration terres/eau et sur les terres humides. Il a en outre tenu deux réunions nationales. La première a porté sur le statut de la classification écologique du territoire au Canada, tandis que la deuxième traitait des applications d'une base de données écologiques. Certaines de ces activités sont exposées dans les publications ci-après:

Comité canadien de la classification écologique du territoire. 1977. Classification écologique (biophysique) du territoire au Canada: Compte rendu de la première réunion du Com. can. de la classif. écol. du terr., du 25 au 28 mai 1976, Petawawa, Ont. Ed. par J. Thie et G. Ironside. Sér. de la Classif. Ecol. du Terr., N°1, Dir. gén. des terres, Envir. Can., Ottawa. 269p.

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N°1: Le CCCET: Historique, buts et groupes de travail;

N°2: Répertoire préliminaire des relevés du territoire au Canada; et Terminologie;

N°3: Rapport du président;

N°4: Données sur la faune dans la classification écologique du territoire;

N°5: L'elément de la végétation dans la classification écologique du territoire;

N°6: L'elément du climat dans la classification écologique du territoire; et Terminologie.

Groupe de travail Intégration terres/eau. 1977. Land/water Integration: Compte rendu de la première réunion, février 1977. Ed. par D. Welch. 70p.

Groupe de travail Méthodologie/philosophie. 1979. Document de travail révisé sur la méthodologie/philosophie de la classification écologique du territoire au Canada (comp. et éd. par. J.S. Rowe), p.31-38 dans: Sér. de la Classif. Ecol. du Terr., N°7, Dir. gén. des terres, Envir. Can.

Welch, D. and E. Wiken. 1979. Canada Committee on Ecological Land Classification. Resource Inventory Notes (April):1-3, Bureau of Land Management, Denver, Co.

Wiken, E.B. and G. Ironside. 1977. The development of ecological (biophysical) land classification in Canada. Landscape Planning 4:273-275.

ACTIVITÉS FUTURES

Jusqu'au début des années 80, les activités du CCCET traiteront surtout de la formation de l'utilisateur, des ateliers sur la classification des terres, de la révision des directives applicables aux relevés écologiques des terres, de la préparation d'une carte écorégion du Canada, et du développement des méthodes de fonctionnement et d'application d'une base de données écologiques.

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Subcommittee on Bio-physical Land Classification. 1969. Guidelines for bio-physical land classification (comp. by D.S. Lacate). Dept. Fish. and For., Can. For. Serv. Publ. No. 1264, Ottawa. 61p.

Wiken, E.B. 1978. The role of national and international coordination in Ecological Land Classification, p. 183-191 in: Integrated inventories of renewable natural resources: Proceedings of the workshop, 8-12 January 1978, Tucson, Arizona. Rocky Mountain Forest and Range Experiment Station General Technical Report RM-55.

RATIONALE AND METHODS OF ECOLOGICAL LAND SURVEYS: AN OVERVIEW OF CANADIAN APPROACHES

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ABSTRACT

A nationally derived system for classifying and evaluating areas of land, as ecosystems, has evolved in Canada over the last decade. It is currently termed an Ecological Land Survey and is composed of three parts: the Survey Proposal, the Ecological Land Classification and the Ecological Land Evaluation. The classification centres upon a holistic concept of land which takes into account both biotic and abiotic characteristics. As the data base developed in this system is broad, it is flexible for a variety of planning, management and interpretative purposes.

RÉSUMÉ

Des travaux effectués au cours des dix dernières années dans l'ensemble du Canada ont abouti à la mise au point d'un système qui permet de classifier et d'évaluer les terres considérées comme éco-système. Ce système, actuellement désigné par l'expression "relevé écologique des terres", comprend trois volets: la proposition relative à la réalisation d'un relevé, la classification écologique des terres et l'évaluation écologique des terres. La classification gravite autour d'une conception globaliste de la terre qui tient compte des caractéristiques biotiques et abiotiques. De par son étendue, la base de données élaborée dans le cadre du système est fort souple et peut servir à toutes sortes d'usages dans les domaines de la planification, de l'aménagement et de l'interprétation.

ROLE

Although environmental concerns are increasingly far-reaching, the majority centre on land resources. The destruction of critical wildlife habitats, the urbanization of prime agricultural areas, the construction of buildings on flood- or slide-prone sites, the pollution of subsurface waters, and the siltation of streams are but a few examples. Typically, in the planning process, these types of concerns are dealt with as singular and independent items. However, because the use of one land resource often simultaneously affects other resources, a cognizant decision should be reached. For example, if a wetland is considered as a site for landfill, then it must be weighed against the loss of other resources associated with that parcel. Will it mean the loss of a unique vegetation community, a waterfowl habitat, an educational site, a natural holding area for surface runoff, a locale for peat deposits, or a recharge zone for subsurface waters? To resolve land-based issues such as these, then, calls for a firm understanding of land itself, especially its inherent parts and their relationships to each other. An Ecological Land Survey can provide much of this.

BACKGROUND

The Ecological Land Survey (ELS) approach has primarily evolved by building upon the efforts of numerous individuals. These have been national, regional and international in origin. The first attempt to generate a set of nationally derived guidelines for ELS took place in the late 1960's. After conducting several meetings, workshops and pilot studies, and after examining numerous regional and foreign approaches, the Subcommittee (1969) on what was then called Bio-physical Land Classification, published their Guidelines (Wiken and Ironside, 1977). The general objective of these guidelines was to document an ecological classification scheme for land which would provide a stable data base suitable for a variety of interpretations. The classification was to be pivotal on ecologically significant units of land. Each unit was to be characterized via its inherent and distinctive combination of climate, geology, physiography, surface materials, soils, hydrology and vegetation. Because the National Committee on Forest Land, which sponsored this Subcommittee, was disbanded in

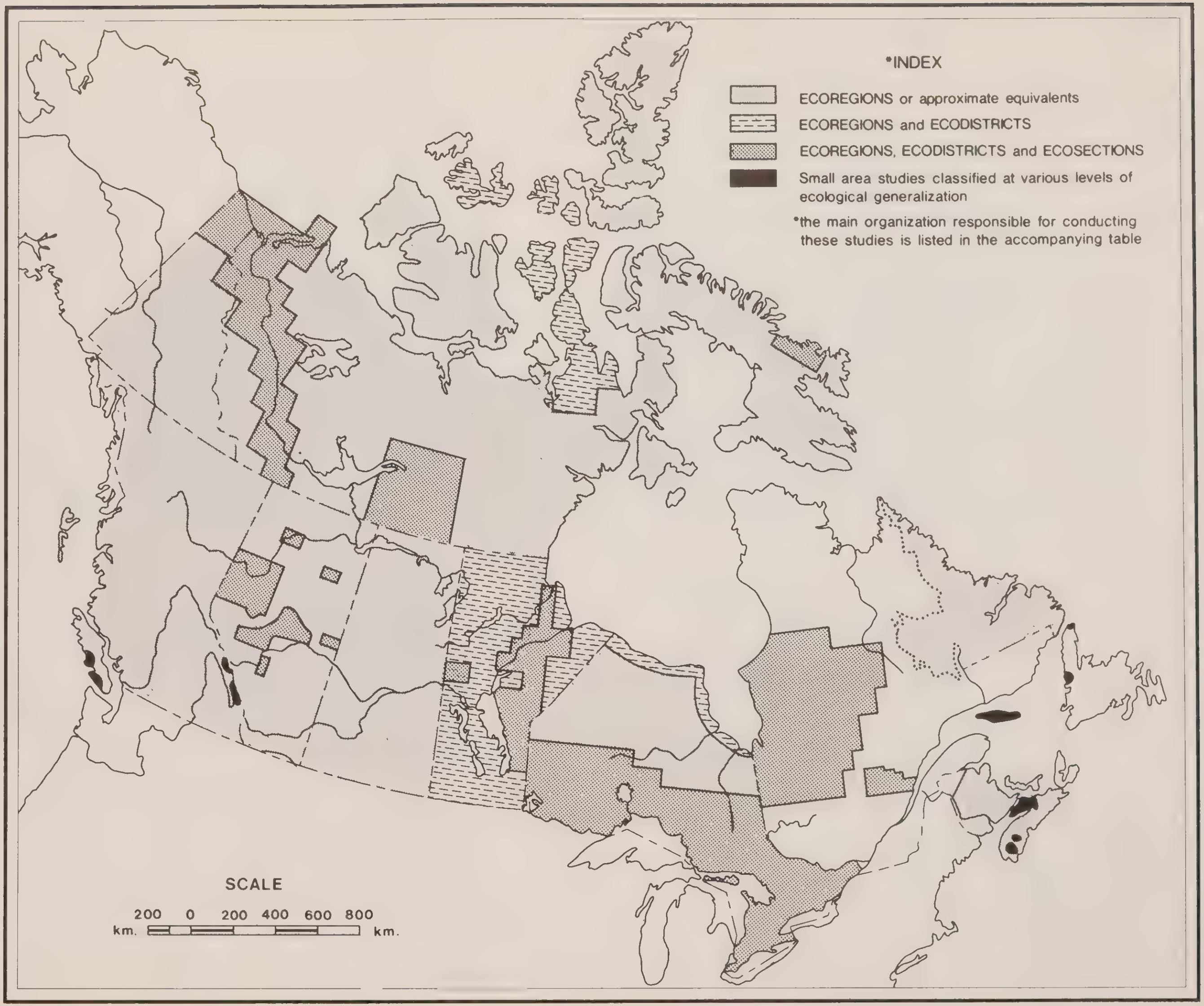

Figure 1: Areas and levels of generalization mapped in Canada.

Table 1: General list of ecological land classification studies.

Territory or Province	Area Covered	Date	Main Organization Conducting the study	Comments
Yukon Territory	Territory	1977	Canadian Forestry Service	Generalized classification of ecoregions
	Northern Yukon	1978	Lands Directorate	Reconnaissance & multi-level classification
Northwest Territories	Territory	1978	Canadian Forestry Service	Schematic classification of ecoregions
	Western Mainland	1977-1978	Lands Directorate	Generalized ecoregions & ecodistricts
	Mackenzie Valley	1973	Canadian Forestry Service & Soil Research Institute	Multi-level classification
	Lockhart River	1978	Institute for Northern Studies	Multi-level classification
	Boothia & Arctic Isles	1970's	Geological Survey of Canada	Classification largely at the ecoregion and ecodistrict levels
British Columbia	National Parks	1960's 1970's	Northern Forest Research Centre	Multiple level classifications
	Province	1965	University of B.C.	"Biogeoclimatic zones"
Alberta	Province	1978	Environment Alberta	"Ecological regions"
	Selected Areas	1970's	Alberta Resource Appraisal Group	Multiple level classification
Saskatchewan	Province	1972	Canada Land Inventory	Schematic ecoregions
Manitoba	Province	1978	Canada-Manitoba Soil Survey	Ecoregions & ecodistricts
	Selected Areas	1970's	Canada-Manitoba Soil Survey	Multi-level classification
Ontario	Province	1960's	Ontario Land Inventory	Ecoregions & multiple level classification in the south
	Northern Lowlands	1978	Lands Directorate & Canadian Wildlife Service	Ecoregions and ecodistricts
Quebec	James Bay	1970's	Lands Directorate	Multiple level classification
Newfoundland	Labrador	1978	Lands Directorate	Schematic classification of ecoregions
	National Parks	1970's	Forest Management Institute	Multi-level classification
Nova Scotia & New Brunswick	Province	1960's	Dept. of Forestry	Ecoregions
	National Parks	1970's	Various Consultants	Multiple level classification

1972, a second approximation was never generated by a nationally represented group. The 1969 Guidelines, however, continued to be used, improved and modified by regional survey organizations in Canada.

DEFINITION AND USE

An Ecological Land Survey (ELS) is an interdisciplinary approach to gathering and interpreting environmental data. The environment, under this approach, is considered to be comprised of natural or man-modified ecosystems which are land-based. As such, land is taken in the holistic sense.

This approach has been employed by various organizations such as the Canadian Wildlife Service, the Alberta Resource Appraisal Group, the Canadian Forestry Service, the Canada-Manitoba Soil Survey and the Geological Survey of Canada. While these groups suggest some tacit indication of the acceptance of the approach, Figure 1 and Table 1 give some inclination of its wide applicability in different environs. Surveys have taken place in the Arctic through to the Prairie Grasslands.

Beyond the confines of Canada, other countries have used approaches which closely parallel the Ecological Land Survey. Examples include the "land systems" approach in Australia (Austin et al, 1977), the "Ecoclass" system in the United States (Carleton et al, 1977) and the "landscape science" in the Soviet Union (Isachenko, 1973).

Because the resources behind each of the surveys thus far completed in Canada have differed, there are "economy" and "luxury" renditions. When time, funds, expertise and materials have been liberal, products which are closer to the idealized model of an Ecological Land Survey have emerged. On the other end of the spectrum, when resources have been limited, the product has swung nearer to a multidisciplinary effort concentrating mainly on soils, vegetation and landforms.

RATIONALE

The resources behind environmental baseline studies is seldom as adequate as surveyors would like it to be. Inadequate funding, not enough time, lack of specialists and support staff, and poor working materials are some of the complaints. While the user or proponent of the baseline study may appreciate these concerns, his discontentment tends to be related more to the information overload which precipitates at the end of the environmental survey. Grumblings such as there is no central or simplifying framework, there are too many technical terms, and there is too much written and cartographic data for us to easily handle are typically echoed. For the surveyor and the user, an ELS approach can circumvent many of these problems; this constitutes the basic rationale for its use. In producing an overall and comprehensive baseline study of the environment, an ELS approach has advantages over a comparable number of single disciplinary surveys:

1) An integrated approach reduces redundant activities in data gathering; as such resources normally spent on duplicating what others have done can be redirected to enhance the baseline study;
2) the more stable aspects of the environment are stressed in the data collection phase, so as to maintain the usefulness of the baseline study over the long term;
3) a team approach to data collection avoids the proliferation of non-concordant map lines for and descriptions of areas of similar environment;
4) the data base is broad and flexible for many purposes;
5) the report(s) and map(s) are amassed into one convenient package for reference and access; and
6) the environmental data is simplified into one common framework.

METHODS OF AN ECOLOGICAL LAND SURVEY

An Ecological Land Survey is usually considered as a process. It consists of three major steps:

(1) Survey Proposal;

(2) Ecological Land Classification; and

(3) Ecological Land Evaluation.

These steps and the activities associated with each are shown in Figure 2.

1. Survey Proposal

The first step of an ELS is perhaps the most crucial and, oddly enough, the least addressed. At this point, the client(s) and the surveyor(s) must discuss the work to be done. The objectives and terms of reference must be resolved and become the same for both parties. This type of dialogue (Figure 3) is intended to sort out the user-doer DT'S. If the interaction between the two parties is fruitful, the end-product of the survey will match in Detail, Time and Scope. Alternatively, if there is not sufficient input at this point, the client-surveyor relationship will not be properly understood; consequently, the results of the assignment will unlikely be satisfactory.

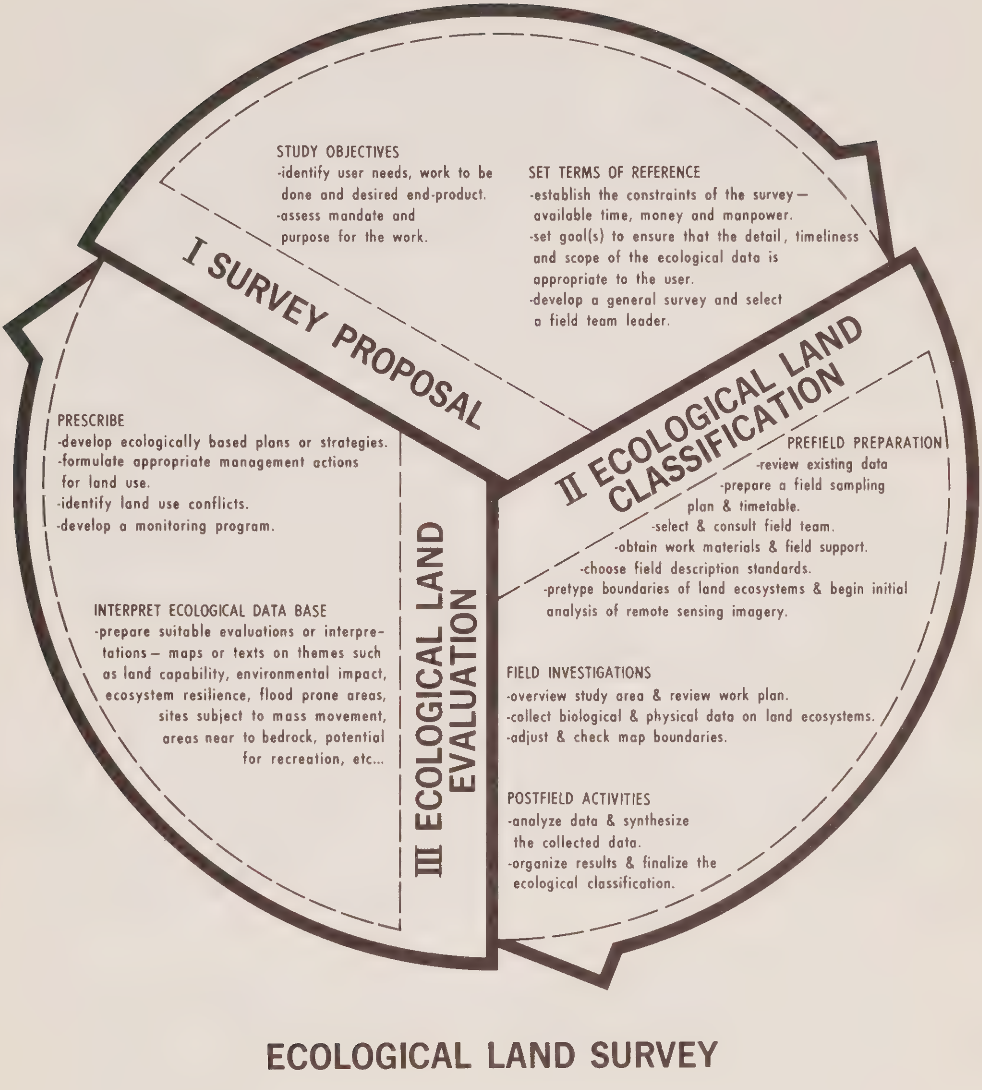

Figure 2: Major steps in an ecological land survey.

Figure 3: Consultation required between the client and the surveyor.

Perhaps along the same concept as the "law of the limiting factor," the amount of use that can be gained from an ELS can be represented by the maximum level to which water could rise in a barrel (Figure 4). At the far left, the DETAIL of the data is the limiting factor. Even though the survey has been adequate in providing the appropriate breadth (SCOPE) of data at the right TIME, the use is curtailed by having insufficient DETAIL. Similarly, there are other instances where not having the proper SCOPE or not having timely data can be limiting.

2. Ecological Land Classification

The second step of an ELS is primarily concerned with data gathering. It is not aimed at collecting all possible forms of land data. Instead, the emphasis is on those sets of data which are useful for many purposes and are keys in the framework of land ecosystems. The gathering of these data relies heavily upon remote sensing analysis coupled with mainly summer field checking.

Remote sensing analysis, which is largely that of conventional black and white panchromatics, yields the preliminary data sets on the biological and physical land characteristics. This interpretation of imagery establishes, as well, the initial map unit boundaries and stratafies the study area into areas of similar environment. To complement the imagery analysis, the pertinent literature for the study area is researched and reviewed. Knowledge of the existing literature enhances the interpretation of the imagery, identifies what data has been previously amassed and provides a firmer understanding of the study area. The field checking which follows is designed to confirm this prefield work, plus to obtain certain forms of data (eg soil and plant samples) which are not readily attainable or possible by other means.

The Ecological Land Classification (ELC) has a particular focus. Depending upon one's interest, an ecosystem can be perceived differently. To a limnologist, it may be an aquatic ecosystem; to a botanist, a plant ecosystem; to a forester, a forest ecosystem; to a wildlife biologist, an animal ecosystem; and so on. With ELC, the focal point is a land ecosystem. This is a comprehensive and holistic concept of land which stems from European literature. It is almost identical to

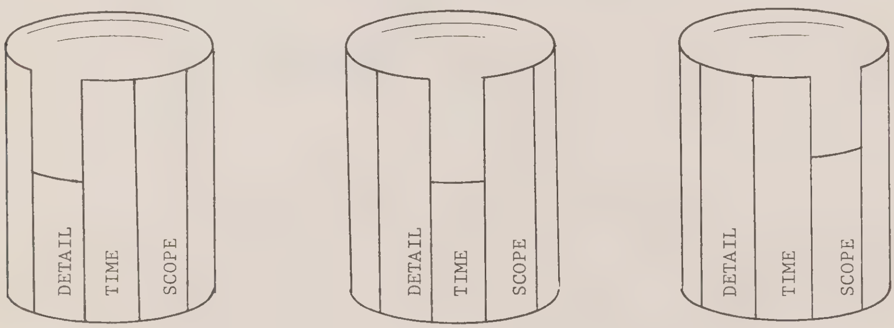

Figure 4: Limiting factors to note in the Survey Proposal step.

Table 3: Levels of ecological generalization proposed by the Canada Committee on Ecological (Bio-physical) Land Classification.

Definitions for the levels of generalization.

ECOPROVINCE - an area of the earth's surface characterized major structural or surface forms, faunal realms, vegetation, hydrological soil and climatic zones.

ECOREGION - a part of an ecoprovince characterized by distinctive ecological responses to climate as expressed by vegetation, soils, water, fauna, etc.

ECODISTRICT - a part of an ecoregion characterized by a distinctive pattern of relief, geology, geomorphology, vegetation, soils, water, and fauna.

ECOSECTION - a part of an ecodistrict throughout which there is a recurring pattern of terrain, soils, vegetation, waterbodies, and fauna.

ECOSITE - a part of an ecosection having a relatively uniform parent material, soil and hydrology, and a chronosequence of vegetation.

ECOELEMENT - a part of an ecosite displaying uniform soil, topographical, vegetative and hydrological characteristics

LEVEL OF GENERALIZATION Common map scale*	COMMON BENCHMARKS FOR RECOGNITION					
	Geomorphology	Soils***	Vegetation#	Climate	Water##	Fauna
ECOREGION 1:3,000,000 to 1:1,000,000	Regional landforms or assemblages of regional landforms	Great groups or associations thereof	Plant regions or assemblages of plant regions	Meso or small scale macro	Water regime	High species diversity; may correspond either to a widely distributed species (eg deer mouse), or to the habitat of individuals within a species.
ECODISTRICT 1:500,000 to 1:125,000	Regional landform or assemblages thereof	Subgroups or associations thereof	Plant districts or assemblages of plant districts	Meso or large scale micro	Drainage pattern; water quality	
ECOSECTION 1:250,000 to 1:50,000	Assemblages of local landforms or a local landform	Family or associations thereof	Plant Associations or a plant association	Large scale micro to small scale micro	River reaches, lakes and shoreland	Less diverse species complement habitat requirements of typical species more restricted (eg beaver, otters); may coincide with specialized areas of animal total habitat (eg wintering area, calving grounds).
ECOSITE** 1:50,000 to 1:10,000	A local landform or portion thereof	Soil series or an association of series	Plant association or seral stage	Small scale micro	Subdivision of above	
ECOELEMENT 1:10,000 to 1:2,500	Portion of or a local landform	Phases of soil series or a soil series	Parts of a plant assoc. or sub-association	Small scale micro	Sections of small streams	Low species diversity habitat of smaller mamals, reptiles and amphibians etc., specialized areas of some fauna's habitat requirements (eg denning areas, local wintering deer yards).

* Map scales should not be taken too restrictively, as they will vary with the environment setting and objectives of the survey
** This level is frequently subdivided into phases according to the stage of plant succession.
*** Canadian System of soil classification, Agriculture Canada, 1979.
# These vegetative groupings are only suggested ones; agreement on a common system is yet to be achieved.
See D. Welch, 1978. LAND/WATER CLASSIFICATION. ELC Series No. 5, Lands Directorate, Ottawa.

the total environment associated with distinctive geographical areas of the earth's surface (Whyte, 1976).

What has constituted a land ecosystem in Canada has varied, depending upon the surveyor's perception and the need to which he was responding. To match the range, a hierarchical system has evolved. Table 2 lists the levels in the hierarchy and provides some indication of the parallel with different orders of planning.

Table 2: Ecological Land Classification and orders of planning.

Hierarchy	Orders of Planning
Ecoprovince	International, Provincial
Ecoregion	Regional, Sub-provincial
Ecodistrict	Sub-regional
Ecosection	Community
Ecosite	Detailed
Ecoelement	Site-specific

As one descends through the hierarchy, certain trends are identifiable. On an average, the map units become smaller, the variability in characteristics decreases and the descriptive data becomes increasingly specific. Table 3 provides further amplification of the hierarchy.

In characterizing any land ecosystem, one attempts to TRAP the essence of each by describing the:

T - things or components present

R - relationships of components

A - abundance of components

P - pattern of components

Six components or THINGS are examined as indicators of the land ecosystem. As it would be impractical, from the standpoint of cost, totally specify and quantify every biological and physical land characteristic, the components are used to provide the framework and subsequently for infilling non-measured data by extrapolation or deduction. The components examined consist of soils, terrain, vegetation, hydrology, climate and fauna. The first four are the most commonly used. Climate is considered an integral inclusion. However, because of the usual dearth of actual data, this component is typically interpreted from trends in soil, vegetation and landform development. Where weather stations, however, are present the data is incorporated. The faunal component is the least employed currently. Each of these six components, when used, are described as they occur spatially within the pedosphere (upper few meters of the earth's surface) and the lower biosphere. This indicates some idea of the dimensions which are attached to these land ecosystems.

RELATIONSHIPS is an inclusive term which is meant to cover notions which go along with such prefixes as inter-, intra-, trans- or otherwise. Relationships largely refer to process and function. Colluvium, cryoturbation, hydrological regime, plant succession, podzolization and climatic regime are examples which indicate factors related to process. Functional relationships may be related by such things as the role of an organic layer as an insulating agent against solar energy penetration or how a water table becomes perched on an illuvial clay horizon.

ABUNDANCE identifies the relative quantities or percentage of things associated with each land ecosystem. This may be expressed as the relative percentage of silt versus sand in the soil. Alternatively, it could cover other characteristics such as the plant biomass production, estimates of water flow, growing degree days, hydrogen ion concentration, available plant nutrients, and species abundance.

PATTERN is directed to the arrangement of component parts in either the vertical or horizontal planes. For vegetation, it could cover the distribution of species in a spatial sense, their structure and their physiognomy. Toposequences and spatial arrangements of climates or soils, depths of water tables, and the order and depths of soils horizons are further examples.

The final activity to perform in an ELC is to present the collected data in a textual and cartographic form, and increasingly so in computer form. The exact format for presenting this data depends on user demands. If users fail to express their desires, the product tends to cater to other surveyors who are familiar with the complex map notations and the texts which are laden with esoteric terms. While in some respects this type of presentation is useful to retain for other surveyors, a simplified base map and text could also be generated to appease the "user" audience. Again, the product which eventuates here as well as in following step (Ecological Land Evaluation) depends on the dialogue and understanding which develops in the initial survey proposal step.

3. Ecological Land Evaluation

In this third and final step of an ELS, the emphasis is on the use of the data base. Evaluations include interpretations (ie land capabilities, land suitabilities, environmental impact, ecosystem sensitivity, etc.) and prescriptive plans and management schemes for various land uses.

The data base which is prepared in the ELC step is geared to permit retrieval via single or multiple descriptive characteristics, or by total systems. Thus, it is extremely flexible for many purposes. It allows the production of single factor or thematic maps, such as the location of potential gravel deposits, areas near to bedrock, and sites having sedge cover. Multiple factor maps and tabulations can also be extracted. A user may wish, for instance, to know of all areas having a combination of characteristics such as an open lodgepole pine-pinegrass community, mixed relief, and small lakes. In some cases, users may wish to retrieve individual land ecosystems having similar characteristics. For illustration, a particular land ecosystem may be rated as excellent wintering habitat for caribou and the wildlife manager may wish to know the extent and whereabouts of similar sites within his management area.

ELC is based on systems relationships. It therefore allows users to predict systems response. An open-pit mining operation in the mountains could, for example, have very little local impact on muskrat populations. However, because this mountainous area acts as the major watershed for a wetland, the siltation of influent streams could have a major downstream impact.

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RAISON D'ÊTRE ET MÉTHODES DES RELEVÉS ÉCOLOGIQUES DES TERRES: UNE VUE D'ENSEMBLE DES MÉTHODES CANADIENNES

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RÉSUMÉ

Des travaux effectués au cours des dix dernières années dans l'ensemble du Canada ont abouti à la mise au point d'un système qui permet de classifier et d'évaluer les terres, considérées comme éco-système. Ce système, actuellement désigné par l'expression "relevé écologique des terres", comprend trois volets: la proposition relative la à réalisation d'un relevé, la classification écologique des terres et l'évaluation écologique des terres. La classification gravite autour d'une conception globaliste de la terre qui tient compte des caractéristiques biotiques et abiotiques. De par son étendue, la base de données élaborée dans le cadre du système est fort souple et peut servir à toutes sortes d'usages dans les domaines de la planification, de l'aménagement et de l'interprétation.

ABSTRACT

A nationally derived system for classifying and evaluating areas of land, as eco-systems, has evolved in Canada over the last decade. It is currently termed an Ecological Land Survey and is composed of three parts: the Survey Proposal, the Ecological Land Classification and the Ecological Land Evaluation. The classification centres upon a holistic concept of land which takes into account both biotic and abiotic characteristics. As the data base developed in this system is broad, it is flexible for a variety of planning, management and interpretative purposes.

RÔLE DE RET

Bien qu'elles soient sans cesse plus nombreuses et plus importantes, la plupart des considérations environnementales intéressent les ressources en terres. La destruction d'habitats fauniques primoridaux l'urbanisation de régions agricoles capitales, la construction de bâtiments dans, des zones inondables ou sujettees aux glissements de terrain, la pollution des eaux souterraines et l'envasement des cours d'eaux ne sont que quelques exemples de ces considération. Il est pratique courante de traiter ces dernières, dans le cadre du processus de planification, en tant que questions singulières et indépendantes. Cependant, puisque l'utilisation d'une ressource influe souvent sur d'autres ressources, il conviendrait de fonder les décisions sur une pondération de différents facteurs. Par exemple, si une terre humide est considérée comme une décharge éventuelle, il faut comparer les avantages à en tirer aux pertes d'autres ressources associées à la parcelle de terre. L'utilisation projetée comporterait-elle la destruction d'une association végétale unique, d'un habitat d'oiseaux aquatiques, d'un site d'histoire naturelle, d'une zone de retene naturelle des eaux de ruissellement, d'un lieu de dépôt de tourbe, ou d'une zone d'alimentation de nappes souterraines? Pour répondre à pareilles questions ayant trait au territoire, il faut bien comprendre celui-là, et particulièrement ses parties intégrantes et leurs intéractions. L'inventaire écologique du territoire peut permettre cela en grande partie.

RENSEIGNEMENTS DE BASE

Le mode actuel d'inventaire écologique du territoire (IET) est surtout l'aboutissement de la conjugaison des efforts de nombreuses personnes sur les plans national, régional et international. La première ébauche de lignes directrices nationales sur l'IET a été publiée vers la fin des années 60. Après avoir organisé plusieurs réunions, ateliers et études pilotes, et après avoir examiné de nombreuses lignes de conduite régionales et

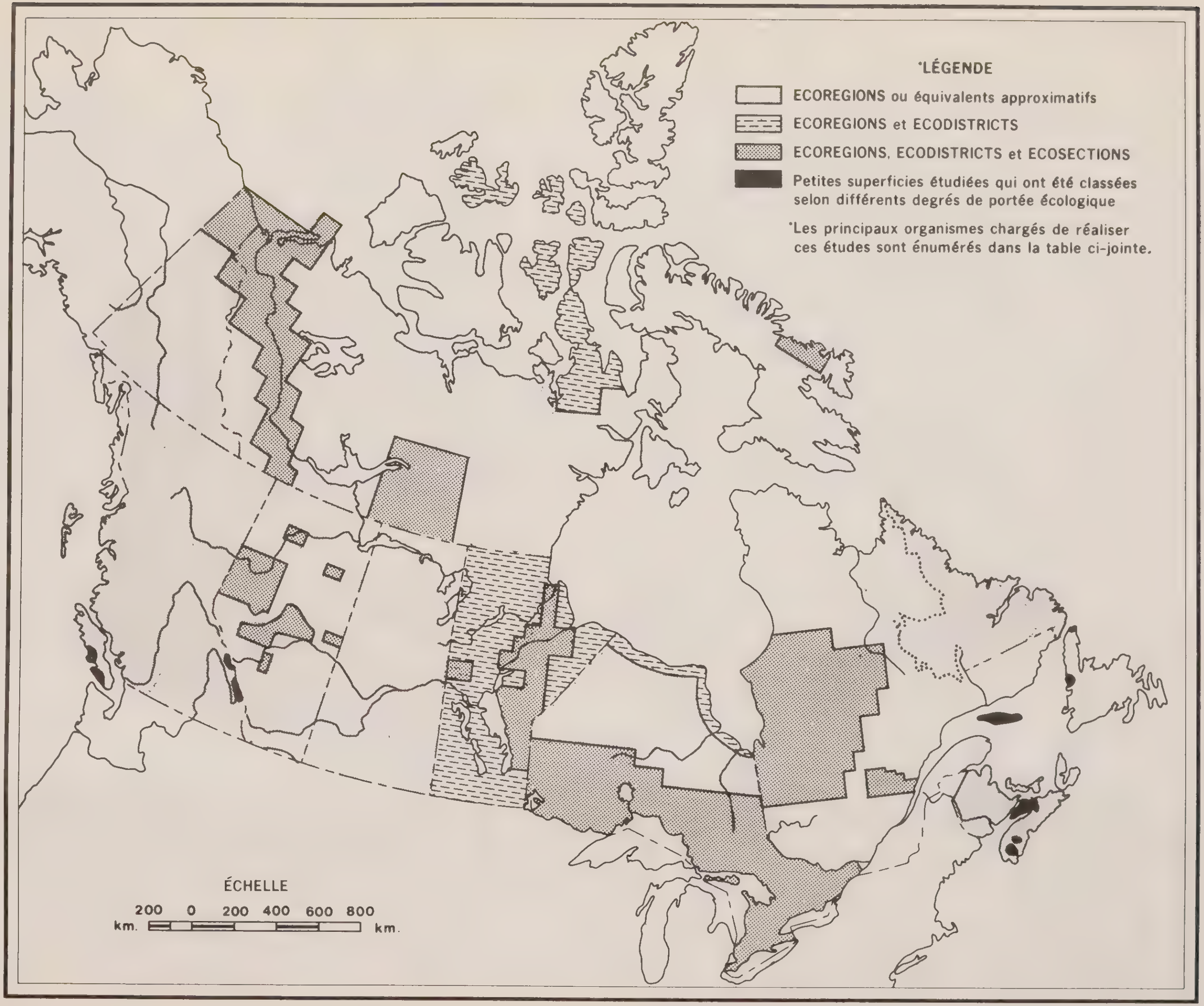


Figure 1: Ampleur et portée des études de classification écologique du territoire au Canada.

Tableau 1: Liste générale des études de classification écologique du territoire.

Territoire ou province	Ampleur	Dates	Principal organisme responsable	Remarques
Territoire du Yukon	Territoire	1977	Service canadien des forêts	Classification générale des écorégions
	Nord du Yukon	1978	Direction générale des terres	Reconnaissances et classifications de différentes portées
Territoire du Nord-Ouest	Territoire	1978	Service canadien des forêts	Classification schématique des écorégions
	Terre ferme côtière de l'Ouest	1977-1978	Direction générale des terres	Classification générale des écorégions et des ecodistricts
	Vallée du Mackenzie	1973	Service canadien des forêts et Institut de recherche sur les sols	Classifications de différentes portées
	Rivière Lockhart	1978	Institut pour les études sur le Nord	Classifications de différentes portées
	Presqu'île de Boothia et iles arctique	années 1970	Commission géologique du Canada	Classification en grande partie à l'échelle de l'écorégion et de l'écodistrict
Colombie-Britannique	Parcs nationaux	années 1960-7	Centre de recherche forestière du Nord	Classifications de différentes portées
	Province	1965	Université de la C.-B.	Zones biogéoclimatiques
Alberta	Province	1978	Ministère albertain de l'environnement	Régions écologiques
	Zones choisies	années 1970	Groupe d'évaluation des ressources de l'Alberta	Classifications de différentes portées
Saskatchewan	Province	1972	Inventaire des terres du Canada	Classification schématique des écorégions
Manitoba	Province	1978	Inventaire canado-manitobain des sols	Ecorégions et écodistricts
	Zones choisies	années 1970	Inventaire canado-manitobain des sols	Classifications de différentes portées
Ontario	Province	années 1970	Inventaire des terres de l'Ontario	Ecorégions et classifications de différentes portées dans le sud de la province
	Terres basse du Nord	1978	Direction générale des terres et Services canadien de la faune	Classifications de différentes portées
Québec	Baie James	années 1970	Direction générale des terres	Classifications de différentes portées
Terre Neuve	Labrador	1978	Direction générale des terres	Classification schématique des écorégions
	Parcs nationaux	années 1970	Institut d'aménagement forestier	Classifications de différentes portées
Nouvelle-Ecosse et Nouveau-Brunswick	Province	années 1960	Ministères de forêts	Ecorégions
	Parcs nationaux	années	Différents experts-conseils	Classifications de différentes portées

étangères, le sous-comité (1969) sur ce qu'on appelait à l'époque la classification biophysique des terres a publié ses lignes directrices (Wiken et Ironside, 1977).

Elles avaient pour but de poser une base de données stable sur la classification écologique du territoire qui se prêterait à différentes interprétations. La classification devait être axée sur des divisions du territoire importantes du point de vue écologique. Chaque division devait être caractérisée par une combinaison particulière de caractéristiques climatiques, géologiques, géomorphologiques, pédologiques, hydrologiques et phytologiques. Puisque le Comité national sur les terres forestières, dont relevait le sous-comité en question, a été démembré en 1972, jamais une deuxième ébauche de lignes directrices n'a été réalisée par un groupe à représentation nationale. Néanmoins, les lignes directrices élaborées en 1969 ont continué à être employées, améliorés et révisées pas des organismes régionaux d'inventaire au Canada.

DÉFINITION ET UTILISATION

L'Inventaire écologique du territoire (IET) est un mode interdisciplinaire d'acquisition et d'interprétation de données sur l'environnement se compose d'éco-systèmes naturels, ou modifiés par l'homme, qui tiennent avant tout aux terres. A cette fin, on étudié les terres dans une optique globaliste.

Le mode d'inventaire a été employé par des organismes tels que le Service canadien de la faune, le Groupe d'évaluation des ressources de l'Alberta, le Service canadien des forêts, l'organisme Canado-manitobain de relevés des sols et la Commission géologique du Canada. Bien que l'intérêt de ces groupes révèle l'acceptation tacite du mode d'inventaire, la figure 1 et le tableau 1 donnent une indication de son applicabilité à un vaste éventail de milieux. Il a déjà servi à des relevés effectués dans l'Arctique et les provinces des Prairies.

Par ailleurs, des pays étrangers ont suivi des lignes de conduite qui ont des liens de ressemblance étroits avec l'inventaire écologique du territoire. Mentionnons par exemple le mode d'inventaire des systèmes des terres employé en Australie (Austin et al , 1977) ; le mode Ecoclass utilisé aux Etats-Unis (Carleton et al , 1977); et les relevés de science du paysage effectués en URSS (Isachenko, 1973).

En raison des différences entre les ressources qui y ont été affectées, les inventaires réalisés jusqu'à maintenant au Canada se répartissent dans des catégories allant, si l'on peut dire, de la classe 'économique' à la classe 'de luxe'. Dans les cas où l'apport de fonds, de connaissance et de matériel a été généreux, on a obtenu des produits voisins du modèle ultime d'inventaire écologique du territoire. D'autre part, dans les cas où les ressources ont été restreintes, les produits tiennent plutôt d'un effort multidisciplinaire axé principalement sur les sols, la végétation et les formes de terrain.

JUSTIFICATION

Les ressources affectées aux études de base sur l'environnement sont rarement aussi importantes que le voudraient les spécialistes intéressés. Parmi les sujets de plaintes de ces derniers on compte les insuffisances de fonds, de temps, d'experts, de personnel de soutien et d'instruments de travail. Bien que l'utilisateur ou le parrain de l'étude de base puisse reconnaître le problème que celà pose, son propre mécontentement portera en général plutôt sur la surcharge d'information qu'il reçoit à la fin du relevé environnemental. Il se plaindra souvent de l'absence d'un cadre d'étude central ou de simplication, d'un surcroît de termes techniques ou d'un volume de données narratives et cartographiques trop important pour qu'il puisse les traiter facilement. L'IET peut obvier à bon nombre de ces inconvénients à l'avantage tant de celui qui l'effectue que ce celui qui l'utilise; ce sont là les assises de son utilisation. Puisqu'il présente une étude de base globale et exhaustive sur l'environnement, l'IET est préférable à un ensemble comparable de relevés uni-disciplinaires pour les raisons qui suivent:

1) L'adaption d'une ligne de conduite intégrée réduit le chevauchement inutile des activités d'acquisition des données et permet d'investir les économies ainsi
2) Les aspects les plus stables de l'environnement sont mis en évidence au cours de l'acquisition des données afin d'assurer l'utilité à long terme de l'étude de base.
3) Le rassemblement des données en équipe empêche la prolifération de cartes et de descriptions discordantes de zones dont l'environnement est semblable.
4) La base de donnée de l'IET est assez large et souple pour permettre de nombreux usages.
5) Puisque les rapports et cartes sont groupés en une seule présentation, ils

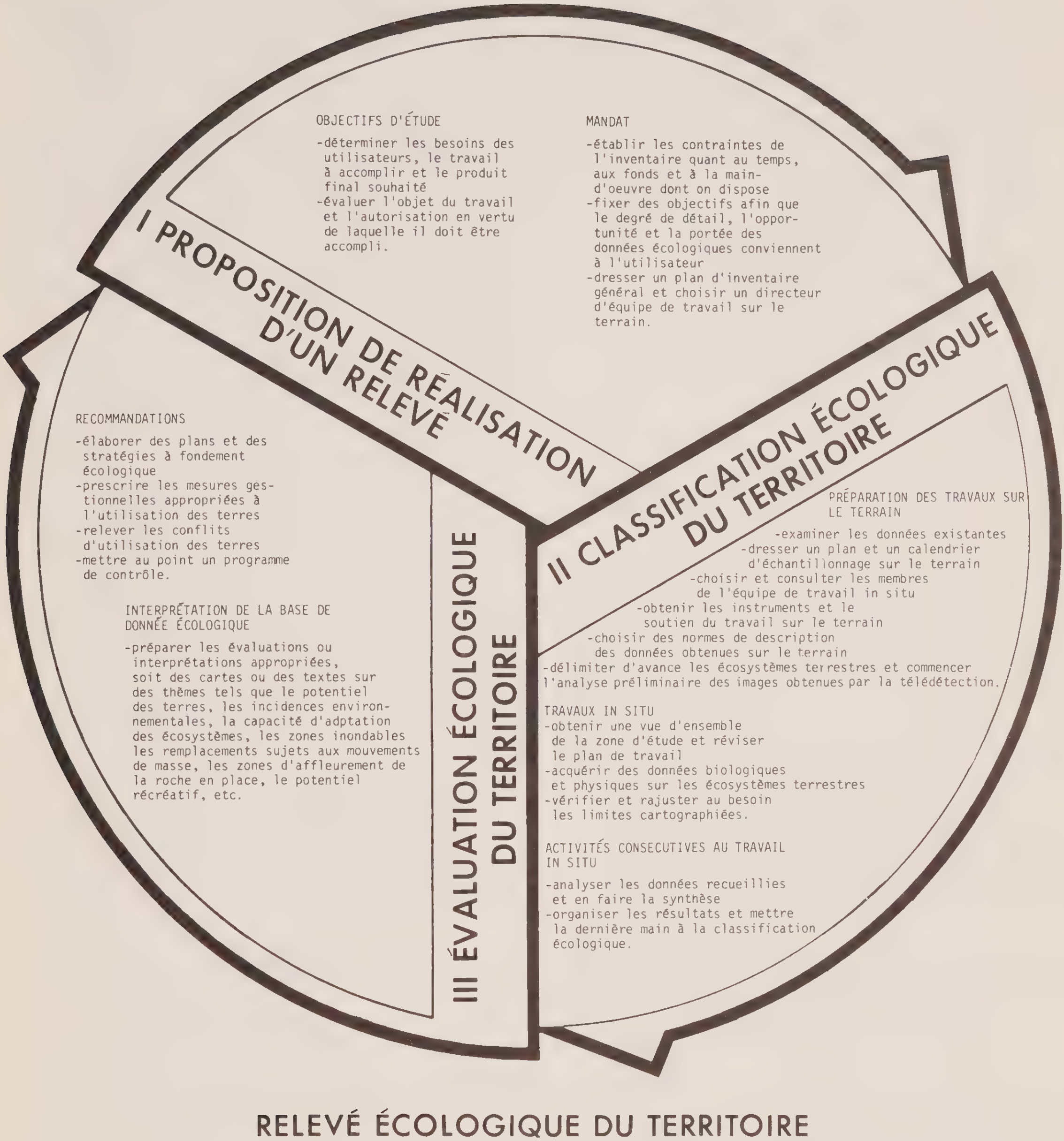


Figure 2: Principales étapes d'un relevé écologique du territoire.

Figure 3: Consultation nécessaire entre le client et l'excécutant de l'inventaire.

sont faciles a consulter

6) Les sonnées environnmentales sont incorporées a un cadre global.

MÉTHODES D'INVENTAIRE ÉCOLOGIQUE DU TERRITOIRE

L'Inventaire écologique du territoire est habituellement considéré comme un procédé qui comprend trois volets principaux:

1) la proposition relative à la réalisation d'un inventaire,
2) la classification écologique des terres, et
3) l'évaluation écologique des terres.

Ces volets et les activités qu'ils comprennent sont indiqués à la figure 2.

1. Proposition de réalisation d'un inventaire

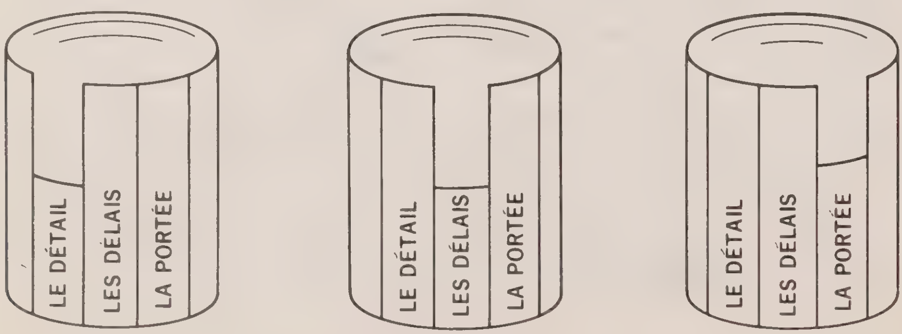
La première phase de l'IET est peut être la plus fondamentale mais, fait curieux, reste celle à laquelle on accorde le moins d'attention. C'est pendant cette phase que les clients et les exécutants doivent discuter du travail à accomplir. Les objectifs et le cadre de référence de l'inventaire doivent être fixés et adoptés par les deux parties. Le dialogue est nécessaire (figure 3) pour permettre d'arrêter les arrangements sur les DDP entre l'utilisateur et le mandataire. Si l'interaction entre les deux parties est fructueuse, le produit fini de l'inventaire correspondra à ces arrangements sur le Détail les Délais et la Portée. Par contre, si l'apport est insuffisant à ce stade, les relations entre l'utilisateur et le mandataire ne seront pas bien comprises et les résultats du travail seront probablement insatisfaisants.

Un peu comme dans le cas de la règle du facteu limitant, l'utilisation maximum d'un IET peut être représentée par le niveau le plus élevé que peut atteindre l'eau dans un baril (figure 4). Dans le baril de gauche de la figure 4, le DETAIL des données est le facteur restrictif. Même si l'on réussit à acquérir dans les DELAIS fixées des données de PORTEE appropriée, leur utilisation est restreinte par l'insuffisance de DETAIL. Dans les autres cas, la PORTEE ou l'opportunité des résultats d'inventaire peut être limitante.

2. Classification écologique des terres

La seconde phase de l'IET consiste surtout à acquérir des données. Il ne s'agit pas d'acquérir les données de tous les ordres possibles sur les terres mais plutôt d'obtenir

Figure 4: Des facteurs restrictifs a observer dans la proposition de réalisation du relevé.



des ensembles de données pouvant servir à de nombreuses fins et visant les principaux éléments de l'infrastructure des écosystèmes terrestres. Cela nécessite une large mesure d'analyse d'images obtenues par télédétection ainsi que des vérifications effectuées surtout l'été sur le terrain.

L'analyse des images obtenues par télédection, qui sont en majeure partie des clichés panchromatiques noirs et blancs de type classique, fournit les ensembles de données préliminaires sur les caractéristiques biologiques et physiques des terres. L'interprération de ces images permet aussi de délimiter initiallement les unités cartographiques et de stratifier la région étudiée en zones d'environnement semblable. Cela va de pair avec la recherche et le dépouillement de documents ayant trait à la région étudiée. La connaissance de ces documents facilite l'interprétation des images, permet de relever les données déjà acquises et sert à mieux comprendre la région à l'étude. La vérification sur le terrain effectuée par la suite est destinée à confirmer les recherches préliminaires et à obtenir certains types de données tels que des échantillons de sols et de plantes que l'on ne peut pas facilement acquérir autrement.

La Classification écologique des terres (CET) a un axe particulier. L'écosystème peut être perçu de bien des façons différentes selon l'intérêt que l'on a. Le limnologiste s'intéressera à l'écosystème aquatique, le botaniste à l'écosystème végétal, le sylviculteur à l'écosystème forestier, le biologiste de la faune à l'écosystème animal, et ainsi de suite. Le foyer de la CET est un écosystème terrestre. Il s'agit d'une notion globaliste des terres qui ressort de la littérature européenne. Elles est presque identique à celle de l'environnement total associé à des régions géographiques particulières de la surface du globe (Whyte, 1976).

Les éléments de écosystèmes terrestres du Canada ont varié en fonction de la perception de ceux qui ont effectué des relevés et des besoins auxquels ils répondaient. Vu la marge conceptuelle qui existe, on a établi un classement hiérarchique. A la table 2 sont énumérés les degrés de la hiérarchie et les différents ordres de planification auxquels ils correspondent.

Certaines tendances se dégagent à mesure que l'on descend dans la hiérarchie. En général, les unités cartographiques deviennent plus restreintes, la variabilité des caractéristiques diminue et les données descriptives sont de plus en plus précises. La table 3 fournit de plus amples renseignements sur la hiérarchie.

Tableau 2: Classification ecologique du territoire et ordres de planification.

Hiérarchie	Ordres de Planification
Écoprovince	Internationale, provinciale
Écorégion	Régionale, sub-provinciale
Écodistrict	Sub-régionale
Écosection	Collectivité
Écosite	Détaillée
Écoélément	Propre à un emplacement

On s'efforce toujours de saisir la substance de chaque écosystème terrestre en décrivant:

- ses éléments,
- les rapports entre ces éléments,
- leur densité, et
- leur répartition.

Six ÉLÉMENTS sont examinés en tant qu'indicateurs de l'écosystème terrestre. Puisqu'il serait financièrement impraticable de décrire précisément et de quantifier chaque caractéristique physique et biologique des terres, les éléments servent de cadre de référence de l'acquisition de données et du calcul subséquent, par extrapolation ou déduction, des données non mesurées. Les éléments examinés sont les sols, la géomorphologie, la végétation, l'hydrologie, le climat et la faune. Les quatre premiers éléments ont les plus usités. Bien que le climat soit considéré comme une partie intégrante de l'écosystème, on se limite à le décrire, en raison de la rareté des données à son sujet, d'après les tendances des sols, la végétation et l'évolution des formes de terrain. Cependant, si des stations météorologi ques existent sur le terrain étudié on incorpore à l'inventaire les données disponibles. L'élément faunique est le moins usité actuellement. Chacun des six éléments, s'ils sont tous employés, est décrit tel qu'il se présente dans la pédosphère (soit les quelques premiers mètres au-dessus de la surface de la terre) et la biosphère inférieure. Cela permet de se faire une idée des dimensions associées aux ecosystèmes terrestres.

Les RAPPORTS visent des notions entraînant l'usage de préfixes tels que inter-, intra- et trans-. Ils correspondent surtout à des processus et à des fonctions. Parmi les facteurs de rapport qui indiquent des processus, mentionnons la colluvion, la cryoturbation, le bilan hydrologique, la chronoséquence végétal la podzolisation et le régime climatique. Le rapports fonctionnels peuvent être révélés notamment par le rôle d'isolant thermique que joue une couche organique ou par la façon dont

Tableau 3: Niveaux de généralisation écologique proposés par le Comité canadien de la classification écologique (biophysique) du territoire.

Définitions des niveaux de généralisation

ÉCOPROVINCE – portion de la surface terrestre caractérisée par d'importantes formes de structure ou de surface, des régions fauniques, des zones, végétales, hydrologiques, climatiques et pédologiques.

ÉCOREGION – portion d'une écoprovince ou le climat produit une réaction écologique particulière, reflétée par la végétation, les sols, l'eau, la faune, etc.

ÉCODISTRICT – portion d'une écorégion caractérisée par une configuration particulière du relief, de la géologie, de la géomorphologie, de la végétation, des sols, de l'eau et de la faune.

ÉCOSECTION – portion d'un écodistrict dans laquelle se retrouve constamment une configuration particulière du terrain, des sols, de la végétation, des plans d'eau et de la faune.

ÉCOSITE – portion d'une écosection caractérisée par une relative uniformité du matériau d'origine, des sols et de l'hydrologie, et par une chronoséquence végétale.

ÉCOÉLEMENT – portion d'un écosite présentant des caractéristiques uniformes en ce qui concerne les sols, la topographie, la végétation et l'hydrologie.

NIVEAU DE GENERALISATION Echelle cartographique commune*	FACTEURS COMMUNS DE RECONNAISSANCE					
	Géomorphologie	Sols	Végétation#	Climat	Eau##	Faune
ÉCOREGION De 1:3 000 000 à 1:1 000 000	Formes régionales du relief ou assemblages de formes régionales du relief	Groupes importants ou assemblages de groupes importants	Régions végétales ou assemblages de régions végétales	Mésoclimat ou assemblages de régions végétales	Régime hydrologique	Grande diversité d'espèces; peut correspondre soit à une espèce très répandue (par exemple la souris sylvestre), soit à l'habitat d'individus d'une espèce.
ÉCODISTRICT De 1:500 000 à 1:125 000	Formes régionales du relief ou assemblages de ces dernières	assemblages d'associations pédologiques	District végétaux ou assemblages de districts végétaux	Mésoclimat ou microclimat à grande échelle	Qualité de l'eau – modèle de drainage	
ÉCOSECTION De 1:250 000 à 1:50 000	Assemblages de formes locales du relief ou une forme locale particulière du relief	Association pédologiques et assemglages de ces dernières	Associations végétales ou une association végétale particulière	Microclimat d'une grande échelle à une petite échelle	Portion de cours d'eau, lacs et rivages	Espèces moins diverses: besoins complémentaires plus restreints d'espèces typiques (par exemple le castor, le loutre) en matière d'habitats; peut correspondre à des secteurs spécialisés de l'ensemble de l'habitat animal (par exemple les zones d'hivernage et de mise bas).
ÉCOSITE** De 1:50 000 à 1:10 000	Forme locale du relief ou portion de cette dernière	Série de sols ou complexe de séries de sols	Association végétale ou stade sérial	Microclimat à petite échelle	Subdivision de ce qui précède	
ÉCOÉLEMENT De 1:10 000 à 1:2 500	Portion d'une forme locale du relief	Phases de séries de sols, ou une série particulière de sols	Parties d'une association ou d'une sous-association végétales	Microclimat à petite échelle	Sections de petits cours d'eau	Faible diversité des espèces; habitat de petits mammifères, reptiles, amphibiens, etc.; régions spécialisées correspondant à certains besoins précis de la faune (par exemple les repaires, les ravages de cervidés).

* Les échelles cartographiques ne devraient pas être considérées de façon trop restrictive car elles varieront selon l'environnement et les objectifs du relevé.
** Ce niveau est souvent subdivisé en phases selon le stade de succession végétale.
\# Ces groupes de végétation constituent seulement des propositions, car il n'existe pas encore de système commun.
\## Voir D. Welch, 1978. CLASSIFICATON TERRES/EAUX. No 5 de la série de la CET, Direction générale des terres, Ottawa.

une napper aquifère se perche sur un horizon. d'argile alluvial.

La DENSITÉ est la quantité ou le pourcentage d'éléments associés à chaque écosysteme terrestre. Elle s'exprime, par exemple, en tant que pourcentage relatif de limon ou de sable dans le sol. Elle peut viser d'autres caractéristiques telles que la production de biomasse végétale, les débits hydrauliques, les degrés-jours de croissance, la concentration des ions d'hydrogène, les substances nutritives que peuvent consommer les végétaux et l'abondance des espèces.

La RÉPARTITION correspond à l'arrangement des éléments sur le plan soit vertical, soit horizontal. Dans le cas de la végétation, elle peut viser la distribution spatiale des espèces, leur structure et leur physionomie. Les toposéquences et l'arrangement spatial des climats et des sols, la gamme des profondeurs auxquelles se trouvent les nappes aquifères ainsi que l'ordre et les profondeurs des horizons du sol sont d'autres exemples de répartition.

L'activité finale à accomplir dans le cadre d'un IET consiste à présenter les données acquises dans des textes ou des cartes et, comme cela se fait de plus en plus, selon une formule informatique. La forme exacte de présentation des données dépend des exigences de l'utilisateur. Si l'utilisateur n'exprime aucune exigence particulière, le produit répond plutôt, en général, aux besoins d'autres groupes chargés d'inventaires auxquels les annotations cartographiques complexes et les textes truffés de termes cryptiques sont familiés. Bien qu'il soit utile de conserver ce genre de présentation pour que d'autres spécialistes s'en servent, il faudrait aussi établir un fond de carte et un texte simplifié destiné au public des usagers. Soulignons de nouveau que le produit de la phase de la classification, comme celui de la phase de l'évaluation, dépend du dialogue et de la compréhension établis au cours de la phase initiale de proposition de réalisation d'un inventaire.

3. Évaluation écologique des terres

La troisième et dernière phase de l'IET est axée sur l'utilisation de la base de la base de données. Les évaluations comprennent des interprétations (par ex, des potentiels des terres, des incidences environnementales, de la vulnérabilité des écosystèmes, etc) ainsi que des plans prescriptifs et des schémas gestionnels en vue de différentes utilisations des terres.

La base de données établie pendant la phase de classification écologique des terres est prévue pour permettre le rappel de données selon une seule ou plusieurs caractéristiques descriptives, ou l'extraction globale d'ensembles de données. Elle se prête donc, grâce à sa grande souplesse, à de nombreuses fins. Elle permet l'établissement de cartes sur un facteur unique ou un thème tel que l'emplacement de carrières de gravier éventuelles, les régions où la roche en place se trouve près de la surface et les zones couvertes de carex. On peut aussi établir des cartes à facteurs multiples. L'utilisateur peut désirer connaître, par exemple, toutes les zones ayant une combinaison de caractéristiques présentant notamment une association à découvert de pin tordu et de calamogrostide rougissant, un relief mixte, ou de petits lacs. Dans certains cas, les utilisateurs peuvent désirer rappeler les données sur des écosystèmes terrestres particuliers ayant des caractéristiques semblables. A titre d'illustration, le gestionnaire la faune peut désirer connaître l'ampleur et les coordonnés d'emplacements semblables, situés au sein de la région qu'il gère, à un écosystème terrestre particulier que l'on a jugé être un excellent habitat hivernal pour le caribou.

L'IET se fonde sur des rapports entre systèmes. Il permet donc aux usagers de prévoir les réactions des systèmes. Par exemple, une exploitation minière à ciel ouvert en montagne peut avoir très peu de répercussions locales sur les populations de rat musqué. Toutefois, puisque la région montagneuses constite le bassin d'alimentation principal d'une terre humide, l'envasement des cours d'eau peut avoir des incidences appréciables en aval.

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WILDLIFE AND WILDLIFE HABITAT IN THE GREAT SLAVE AND GREAT BEAR LAKE REGIONS 1974-1977

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ABSTRACT

The Land Use Information Series of maps has developed into the major systematic environmental-social research and information program for Canada. The deliniation and description of important and critical areas for wildlife is one of the primary thrusts of the research program. This paper describes the methods, objectives, and some of the results of one of the wildlife studies done during the program in the Great Slave and Great Bear Lake regions of the Northwest Territories.

RÉSUMÉ

La Série de cartes d'information sur l'utilisation des terres est devenue le principal programme d'information et de recherche systématiques dans le domaine socio-environnemental pour le Nord canadien. La délimitation et la description des zones importantes et critiques pour la faune est l'un des principaux objectifs du progranne de recherche. Ce travail explique les méthodes, les objectifs et quelques uns du résultats auxquels a conduit l'une des études sur la faune entreprises dans le cadre du programme de recherche établi pour les régions du grand lac au Esclaves et du grand lac des ours dans les Territoires du Nord-Ouest.

INTRODUCTION

In 1971 the Department of Indian Affairs and Northern Development established the Arctic Land Use Research (ALUR) Program to provide baseline environmental information about the Yukon Territory and the Northwest Territories. As part of this program, the Lands Directorate of Environment Canada undertook the preparation of Land Use Information Series maps (1:250,000 scale) which summarize information on renewable resources and related human activities. The Canadian Wildlife Service was responsible for providing information on wildlife and wildlife habitat for the map series.

From February 1974 through March 1977, Environment Canada carried out research for the Land Use Information Series in the forest and tundra areas surrounding Great Slave and Great Bear lakes in the Northwest Territories. During that period, the author worked as a wildlife ecologist, under contract to CWS, as part of the interdisciplinary team which produced the map series. As part of the primary research, a series of year-round, multi-year wildlife surveys were conducted over approximately 518,000 km^2, essentially between 60^{o}N and the Arctic Coast and from the Mackenzie Valley east to well onto the tundra (Figure 1).

OBJECTIVES

The study aimed to define critical and important wildlife habitat and wildlife functions for culturally important species. This information was to be mapped at a 1:250,000 scale with accompanying narrative in conjunction with the other subjects. Detailed methods and observations, in excess of the information portrayed on the map sheets, were to be presented in handbook form.

Some species and some areas were mapped from existing information, and therefore received minimum emphasis during the field studies. The bulk of the information gathered as a result of field and library research appears on the 48 published map sheets. There, data are portrayed spatially, with an accompanying narrative, to denote critical and important habitat, populations or species functions.

NATURE OF THE STUDY

The wildlife species studied were selected largely on the basis of social values. Habitats that were important or critical for the maintenance or survival of wildlife populations were outlined and ecosystems (wildlife zones) were described. Animals studied included: moose, barren-ground caribou, woodland caribou, bison, bears (grizzly and black),

red fox, lynx, muskox, marten, wolverine, muskrat, mink, otter, beaver, Arctic fox, wolf, waterfowl, and raptors (falcons and eagles).

The vast area of forest and tundra which provides the habitat for the diverse wildlife of this study consists of many interrelated ecosystems: bog transitions to forest, prairie to lake, and open forest to tundra. Sharp contrasts also can be found, such as the vegetation of eskers versus adjoining tundra or forest, forest composition of the sedimentary plain versus that of the Canadian Shield, or great variations in tundra vegetation, depending on underlying substrata.

Mapping wildlife habitat and its use by wildlife, especially on a reconnaissance level, requires many value judgements concerning habitat differences. Often the mapping of land use for a certain species would suggest a series of slightly differing ecosystems at one level of detail, but a further analysis for another species or group of species would suggest a much larger and more generalized ecosystem. Thus, barren-ground caribou winter range may encompass virtually the entire open forest of the Canadian Shield, while within this same area, only certain river systems are used by otters for winter feeding. Marten may be common or abundant throughout the forests of the sedimentary plain whereas beaver may only be abundant in a small part. Some species appear to use the same ecosystems but are concentrated in very different parts of it. For example, an esker system may provide abundant arctic fox denning sites, whereas a nearby pond system provides whistling swan nesting sites. Some species, very closely associated during part of the year and using the same habitat, are widely separated during the remainder of the year. Barren-ground caribou and wolves, for example, are interrelated and together on their winter range, yet have their young in widely separated locales partly for habitat-related reasons. Yet, in other ecosystems, wolves and other species, (eg bison and to some extent moose and woodland caribou) may live year-round together.

These and many other differences and similarities are reflected in the LUIS maps. The maps and the information portrayed are often general in appearance, but the symbols and legends reflect the overall, many-year use of the entire ecosystem, based on multi-year surveys, interviews, literature review and habitat study.

Because of the long lead time required for a project of this nature, from initial budget planning through to the final map printing, essentially several years are available for surveys. Initial interviews, literature review and surveys are generally begun up to a year before the start of the specific area field work. Data is frequently available from adjacent and similar study areas or from surveys which were extended beyond previous study area boundaries.

THE STUDY AREA

The large study area covered by the project consisted of a number of diverse ecosystems. The individual large ecosystems (wildlife zones) are briefly described below, from southwest to northeast (Figure 1 and Table 1). The area is part of the tundra, forest-tundra, and open woodland, boreal bioclimatic divisions of Hare and Ritchie (1972). The wildlife zones generally are equivalent to the land regions or eco-regions of Tarnocai and Netterville (1975) in northern Keewatin, N.W.T.; of Mills (1976) in northern Manitoba; and of Oswald (1976) in the Yukon Territory.

Bog and Forest Wildlife Zone

This wildlife zone covers the area west of Great Bear Lake in the Hare Indian River vicinity, and from southwest of Great Bear Lake to west and south of Great Slave Lake. It includes the area between the Horn and Cartridge plateaus, the Mackenzie Bison Sanctuary, and the area adjacent to Wood Buffalo National Park in the Northwest Territories.

Numerous shallow lakes, large bogs, and extensive spruce and jackpine forests characterize this zone. Terrestrial and orboreal lichens are abundant in the mature spruce stands, and large sedge meadows and willow-sedge parklands surround the shallow lakes. This wildlife zone provides good habitat for moose, woodland caribou, wood bison, black bear and geese. Most forest and aquatic furbearers can be found here.

The Slave River plain and delta, with their many sloughs, ponds, and old channels, is possibly the most productive portion of this wildlife zone,and was identified separately on the published maps. Vegetation is very diverse, ranging from prairies to aspen parkland to dense spruce forests. This is a unique part of the sedimentary plain bog and forest wildlife zone. The delta is abundant with muskrats and other aquatic furbearers and ducks. Plains-wood bison, moose, wolves, black bears, lynx and forest furbearers are abundant throughout the area.

Figure 1: Locations of wildlife zones.

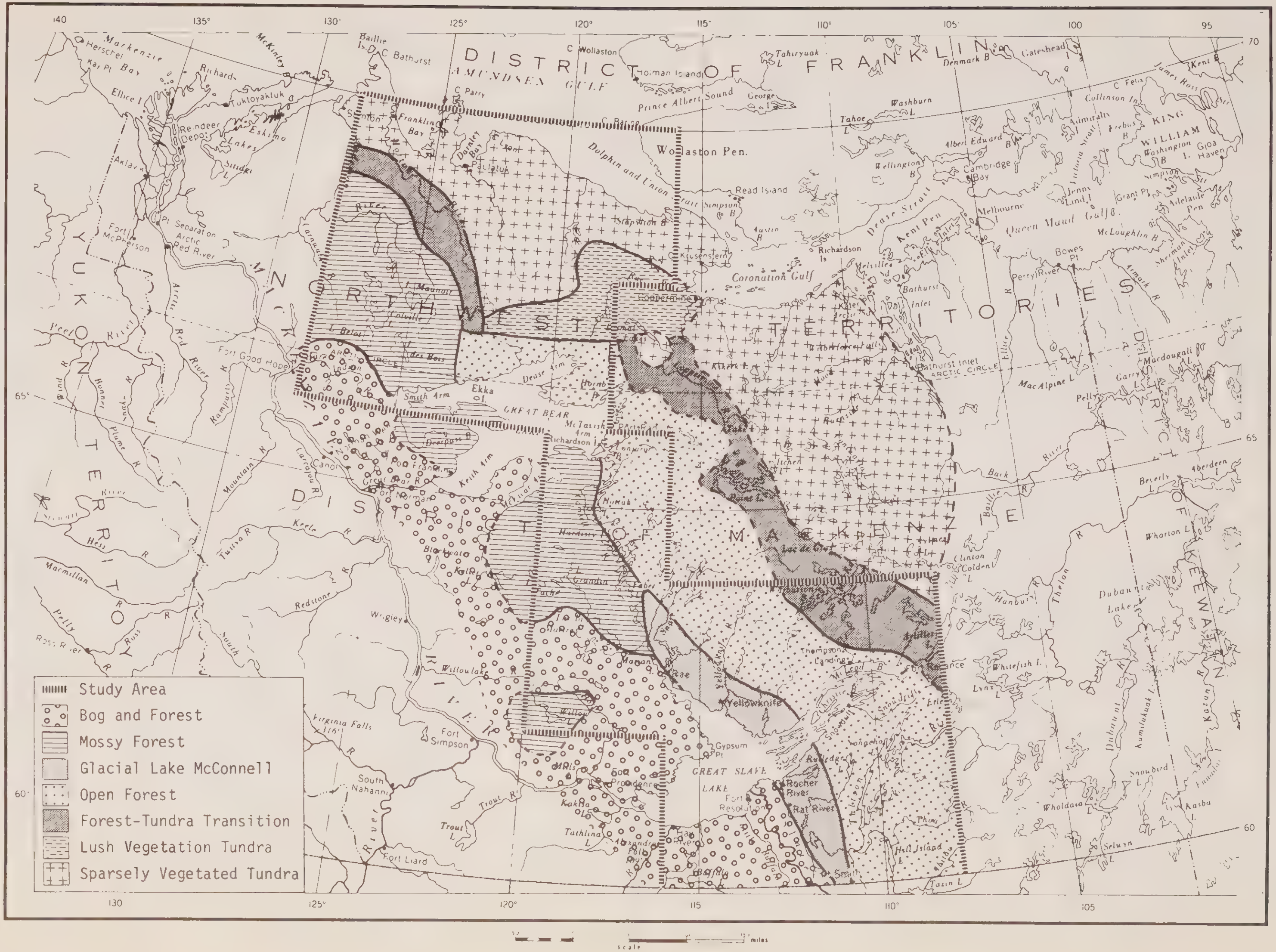

Table 1: Summary of wildlife observations.

SPECIES	RANGE IN STUDY AREA	NOTES: HABITAT	NOTES: POPULATION & BEHAVIOUR
UNGULATES:			
Moose	Forested portion	River valleys provide important winter habitat on the Shield. Fires appear to locally influence populations.	Abundance depends on major ecosystem types. - forests of sedimentary plain. - former Glacial Lake McConnell. - open forest of Canadian Shield.
Barren-ground caribou		Most open forest and all Shield woodland provides winter range	Study area includes calving grounds and and migration routes for the Bluenose herd and portions of migration routes for the Bathurst and part of the Beverly herd. Fire appears to adversely affect winter range use
Bluenose herd	North of Great Bear Lake	Winter range	
Bathurst herd	Between Great Bear and Great Slave Lake	Large forest area provides winter range	
Beverly herd	Southeast of Great Bear Lake	Forest area provides part of herd's winter range	
Woodland Caribou	All forest on sedimentary plain, south and west of Great Bear Lake	Year-round habitat	Some seasonal migrations apparent. Some calving areas used annually.
Bison	Immediately south of Great Slave Lake	Habitat for bison populations is an extension of the ecosystem of the northern part of Wood Buffalo National Park	Some very distinct differences between the two bison populations.
Muskox	North of Great Bear Lake	Tundra	Some herds are very large.
CARNIVORES:			
Wolf	Throughout the study area, both forested and tundra portions	Prime denning habitat in the forest-tundra transition zone	Abundant in the Slave River lowlands, associated with bison. Associated with moose in portions of the Glacial Lake McConnell area. Locally abundant in barren-ground caribou winter range.
Foxes			
Red	Common throughout the forest and well onto the tundra	Locally abundant in willow areas in late winter	

Table 1 cont'd.

SPECIES	RANGE IN STUDY AREA	NOTES	
		HABITAT	POPULATION & BEHAVIOUR
Arctic Fox	Throughout the tundra and well into the forests in winter	Den through the tundra but several ecosystems have very abundant den sites	
Bears			
Black	Throughout forested portion		Locally abundant in the sedimentary plain forests along sandy river systems of the Shield during spring
Grizzly	Common throughout entire forest-tundra and tundra portions	Spring: appear to concentrate in major river valleys Summer: range widely including well into the forest.	
Marten	Throughout the forested portion		Locally abundant in portions of the sedimentary plain forests, especially the Horn Plateau and north and south of Great Bear Lake.
Muskrat, mink and beaver	Throughout the forested portion		Very abundant in the Slave River lowlands and delta. Abundant in the area of Glacial Lake McConnell.
Otter	Throughout the forested portion	In winter, associated locally with rapids which provide necessary feeding habitat	
Wolverine	Throughout the study area		
Lynx	Forests of the sedimentary plain and the Canadian Shield and the area of Glacial Lake McConnell		Locally abundant in the sedimentary plain and the area of Glacial Lake McConnell.
Waterfowl			
Swans	Throughout the study area in spring, summer, and early fall		Locally abundant in some ecosystems north of Great Bear Lake. Fall staging in several areas (large numbers).
Geese and ducks	Throughout area in spring, summer and early fall		Summer nesting. Heavy spring and fall staging.
Raptors			
Eagles	Throughout area		Bald eagles common in the forested portions. Golden eagles common on the tundra.
Falcons	In specific nesting habitats		Not common.

Mossy Forest Wildlife Zone

Extensive spruce forests with many lakes and, where unburned, a relatively deep carpet of mosses and lichens, characterize this wildlife zone. Burned areas are common. Rivers tend to be dark in color. Much of the area is underlain by a gravelly moraine. This ecosystem extends northwest of Great Bear Lake, southwest of the Anderson River valley, and includes several large lakes; Colville, Aubrey, and Maunoir. South of Great Bear Lake it extends to west of Hottah Lake to include the Lac Grandin area and southwest to include the Cartridge Plateau. This is also the ecosystem of the Horn Plateau.

Moose and marten are abundant and barren-ground caribou use this area for winter range. Black bears are very common, and wolverine, red fox and most forest and aquatic furbearers can be found throughout the zone. Wolves and grizzly bears are often found here and many swans, geese and ducks use this area from spring through fall.

Glacial Lake McConnell Area Wildlife Zone

The area east of the lower Taltson River and northeast of Great Slave Lake, from lake level up to 260m , is influenced by deposition from Glacial Lake McConnell. This area extends, on the Shield, north from Great Slave Lake to Faber Lake.

On the Canadian Shield, most lakes are rock-bordered and deep and generally have spruce forest to the edge. In the area of Glacial Lake McConnell influence, the lakes and ponds generally have a border of willows. This adversely affects barren-ground caribou resting preference, hence winter range, but provides excellent moose winter range and beaver habitat. Lynx and red fox are locally abundant in winter.

Open Forest Wildlife Zone

The large open forest area southeast of Great Bear Lake to southeast of Great Slave Lake is prime barren-ground caribou winter range. Deep, rocky lakes and fast-flowing rivers occur throughout this wildlife zone. Although limited numbers of most wildlife species may be found here, its prime use is as barren-ground caribou winter range.

Forest-Tundra Transition Wildlife Zone

From northwest to southeast, along treeline, the 16-80 km wide transition zone provides habitat for many species commonly found in both tundra and forest. Vegetation common to both ecosystems can be found here. Wolves den in abundance in the sandy eskers of this transition zone. This zone varies according to fire history, elevation, and substratum.

Sparsely-Vegetated Tundra Wildlife Zones

North of Great Bear Lake, from the Anderson River watershed east to the Rae and Richardson river headwaters, and along the Arctic coast, the tundra is sparsely vegetated. Most tundra species occur, but a few in any abundance. Muskox live year-round and barren-ground caribou calve in this wildlife zone.

Lush Vegetation Tundra Wildlife Zones

The headwaters of the Bloody and Haldane rivers and the Rae and Richardson rivers, and the river valleys, contain lush willow and sedge vegetation. This area has many muskox, Arctic fox dens, whistling swan nests and many other tundra wildlife species.

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THE BIOPHYSICAL WILDLIFE INVENTORY OF BANFF AND JASPER NATIONAL PARKS

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ABSTRACT

The wildlife inventory of Banff and Jasper National Parks has integrated its methodology and reports into a biophysical land classification. Most methods are simple and fast, yet quantitative, requiring many replicates for an adequate sample. Wildlife maps prepared at a scale of 1:50,000 and based on the land classification can accurately depict abundance and distribution. Problems and solutions concerning the land classification are discussed and the many users of the wildlife inventory are identified.

RÉSUMÉ

La méthodologie et les rapports de l'inventaire de la faune des parcs nationaux de Banff et de Jasper ont été intégrés à la classification biophysique des terres. La plupart des méthodes sont simples et rapides, mais il faut les répéter un grand nombre de fois pour obtenir un échantillon adéquat. Les cartes sur la faune faites à l'échelle 1:50 000 et basées sur la classification des terres illustrent avec exactitude l'abondance et la distribution des animaux. L'inventaire de la faune contient un examen des problèmes et solutions relatifs à la classification du territoire et une liste de ses nombreux usagers.

INTRODUCTION

At the request of Parks Canada in 1973, a biophysical inventory of Banff and Jasper National Parks was planned with the Canadian Wildlife Service, Canadian Forestry Service and the Alberta Institute of Pedology. The inventory was initiated in 1974 in two parts, a land inventory and a wildlife inventory in the Lake Louise area of Banff (Stelfox et al, 1975; Walker et al, 1978a).

The biophysical land classification, which is due to be completed in March 1981 has now reached a relatively stable structure after 4 years of evolution (Holland, 1976; Walker et al, 1978). The classification system comprises of 3 zones and 2 Subzones, Alpine, Subalpine Upper and Lower and Montane. These are further subdivided into Land Systems on the basis of landform features, soil type, soil moisture, parent material texture, calcareousness, soil vegetation mesoclimate classes and landform surface expression. The Land Systems are in turn divided into Map Units using physiognomic groupings of vegetation (closed forest, open forest, shrubland, low shrubland and grassland), soil parameters where the areal extent is limited (eg imperfectly drained soils), and selected vegetation types that reflect wildlife habitat. Finally the classification system includes modifiers to the Map Units such as slope, recent burns, and avalanche activity. The parks are mapped at a scale of 1:50,000 (Walker et al, 1978b).

The objectives of the wildlife inventory are to obtain basic quantitative information regarding the seasonal abundance, distribution and habitat characteristics of all species of mammals, birds, amphibians and reptiles that occur in Banff and Jasper National Parks and to present the data in map and report form (Anon, 1977). The need for mapped information requires the wildlife inventory to integrate its sampling and reports with the land classification (soil and vegetation). Recent wildlife inventory reports have presented interpretations of the data that are suitable for specific purposes such as land use planning and single species management (Holroyd and Gartshore, 1978; Holroyd et al, 1979; Karasiuk et al, 1978). In this paper I shall discuss the inventory methodology and our approaches and problems in integration of wildlife data with other land classification data.

METHODS

By necessity, the sampling methods that were employed were fast and simple, yet quantitative. These methods permitted a limited

number of personnel to sample relative abundance and distribution of approximately 300 wildlife species in more than 160 Map Units. The sampling program is being conducted over six years (1975-1981) to gather data regarding wildlife occurrence in each Map Unit. Samples are randomly located in polygons of each Map Unit and are distributed to sample all geographic areas of the two parks. The 300 species were grouped for quantitative sampling by relatively few techniques (Table 1).

Space does not allow a detailed description of the field methodology but the following notes will orient the reader to this project's techniques. Pellet groups are counted in twenty-five 10 sq m quadrats that are spaced in a 5 x 5 grid with an interval of 50 m between sample points. Tracks are counted in winter along 0.5 km line transects and are corrected for the number of days since last snowfall. Snow depth is also recorded on each transect. Snap trap lines consist of 100 Museum Special snap traps set in pairs at 10 m intervals for two nights. The catch per effort is expressed as the number of individuals per 100 trap nights, corrected for sprung traps. Pitfall trap lines consist of twenty 1.36 litre juice cans with one end removed and set flush with the ground at 10 m intervals for 5 to 10 days. The catch per 100 trap nights is used to compare samples. Weasel live traps are wooden, home-made traps measuring 12 x 12 x 60 cm that are baited with sardines, peanut butter, kippered herring or strawberry jam. Call count surveys are conducted along 0.5 km transects measured by pacing. Number of birds seen and heard is recorded and totals were corrected for species detectability (Emlen, 1971). Breeding bird grids were established on 10 ha tracts where the spot mapping technique is employed during 8 visits of each tract (Hall, 1964). Road surveys for birds follow the technique for breeding bird survey by automobile described by Erskine (1972). Observation surveys for ungulates are conducted from roads along standardized routes that incorporate visual searches for ungulates on open areas visible from the roads.

One of the objectives of the wildlife inventory is to present information on the seasonal abundance of wildlife that can be displayed on maps. This objective is accomplished by ranking the occurrence of wildlife species (either singly or in groups) on each Map Unit. This ranking is then evaluated as to its importance to the requirements of the species or groups of species. The process of ranking is as follows. The data from each sample methods is computer mainipulated to produce an average quantity for each Map Unit and each vegetation type. The quantities for the Map Units are then ranked as none, low, medium, high and very high so as to compare the wildlife species use of each Map Unit. The ranking is determined by dividing the number of non-zero quantities by 3 and assigning 1/3 of the Map Units to each of low, medium and high. To date, the importance of a Map Unit has been the same as the ranking when single species are considered (ie ungulates and carnivores). For small mammals and breeding birds the total ranking for all species and the number of species are combined to evaluate the importance of the Map Units. Important habitats are those represented by the important Map Units and vegetation types. Critical habitats have yet to be defined but may correspond to the very highly ranked Map Units plus all habitats with limited functions and restricted areas (eg denning, calving, staging, etc).

RESULTS

The inventory data are reported in four sections. The Wildlife Legend forms the core of the report for cartographic purposes (Table 2). This legend allows the land use planner or his computer to plot species occurrence on base maps showing the Map Units and thus compile a distribution map. The Map Unit Account describes the importance of the unit to wildlife and may include management considerations. In addition, the Species Accounts detail the abundance and distribution of various species in the park, with habitat preferences, reproductive information, management considerations, relation to Map Units and vegetation type correlates. The report's final section provides the major and minor species of breeding bird communities and small mammal associations and their Map Unit occurrence and vegetation type correlates.

Additional data have also been collected for the final report. Cover and forage vegetation have been sampled for correlation with ungulate pellet group counts to provide background when discussing ungulate habitat requirements on each Map Unit. Scats have been collected to determine carnivore food habits. These data on diet together with information on the distribution of prey may be used to explain carnivore distribution. Spring and fall road surveys have documented the migration of birds within the parks and the seasonal use of some major ranges by ungulates. Reproductive information from small mammals have been used to predict each

Table 1: The matrix of species groups that are sampled by each method. Sample sizes include data from both Banff and Jasper from 1975 to 1979.

SPECIES / TECHNIQUE	Ungulates	Carnivores	Varying hare	Red squirrel	Small mammals	Breeding birds	Migrating birds	Wintering birds	Sample size
Pellet group counts	•		•						1122
Track count transects	•	•	•	•				•	874 km
Snap trap lines					•				252
Pitfall traps					•				10
Live traps (weasels)	•								500 trap nights
Call count transects				•		•			574 km
Breeding bird grids						•			13
Road surveys	•					•	•	•	9 routes
Random observations	•	•	•	•	•	•	•	•	40,000

small mammal species' productivity and resilience to population crashes. This information is outside of the requirements of a biophysical inventory but it is an integral part of any complete wildlife inventory.

DISCUSSION

This wildlife inventory uses the Map Unit of the land inventory, samples wildlife abundance on the Map Unit and then ranks the Map Units to identify important and possibly critical areas. The wildlife inventory also provides an opportunity for additional field checks on the mapping of the Map Units, occasionally leading to corrections in the working map or in the definitions of the Map Units.

This approach to an integrated wildlife inventory has solved some of the problems that plague ecological inventories. All of the information is plotted at one scale, 1:50,000, thus simplifying the production of maps and overlays. The wildlife inventory is phased one year behind the land inventory so that the wildlife data can use working maps of the land classification in each year's study area. The wildlife inventory also uses the vegetation classification to describe habitat preferences of wildlife thus ensuring integration of all landscape characteristics into a single classification system. Because the wildlife and land inventories overlap with only one year difference the wildlife inventory personnel can use the land classification to identify problem areas and attempt to have the land classification modified to suit their needs. These problems are not always fully solved to everyone's satisfaction.

An inherent problem, for wildlife purposes, in this inventory is that the land classification approach to vegetation classification has not presented information on vegetation structure. While open forests are differentiated from closed forests and the vegetation types are sometimes related to stand age, there is insufficient information to construct, for example, foliage height diversity indices that are useful to predict some wildlife values. Hopefully future land classifications could include such vegetation information. However, since wildlife are sampled directly with quantitative techniques the relative importance of the Map Unit and vegetation types can be determined without requiring the use of habitat assessment

Table 2: Example of the biophysical wildlife legend for Banff and Jasper National Parks.

LAND SYSTEM	Map Unit	Season	Caribou	Mule deer	White-tailed deer	Moose	Elk	Mountain goat	Bighorn sheep	Timber wolf	Coyote	Red fox	Black bear	Grizzly bear	Marten	Fisher	Weasel	Mink	Wolverine	Cougar	Lynx	Varying hare	Beaver	Porcupine	Marmot	Columbian Grd. Squ.	Red squirrel	SMALL MAMMALS DENSITY INDEX	SMALL MAMMALS SPECIES TOTAL	SMALL MAMMALS COMM. TYPE	BREEDING BIRDS DENSITY INDEX	BREEDING BIRDS COMM. TYPE	SPECIES TOTAL
Altrude	AL1	Winter		M	P	M	H				L		P	P	L		L	L	L		P	L											
		Summer		L		L	L																	P		P	M	L	6	3	M	4	25
	AL2	Winter		L		H	M	L	L	L	L				M		M	L	L		P	M											
		Summer		L		L	L		L													L		P			M	L	2	4	M	4 25,5	20
	AL3	Winter		P		L	M			–	–	–	–	–	–	–	–	–	–														
		Summer		L			L						P											P			H			–	H	4	17
Athabasca	AT1	Winter		V		L	V			M	H				M		L					L											
		Summer		L	P	L	H						P	P						P						P	H	H	2	3,2	M	14,4	11
	AT2	Winter		H		M	H		L		H				M							H				P	H						
		Summer		L		L	H		L																	P	H	H	6	3,2	M	4	19
	AT3	Winter		–	–	–	–	–	–	M			P	P	M		M			P		–											
		Summer		P	P		P															–					M	M	1	2	H	14	18
	AT4	Winter		H			H				–	–	–	–	–	–	–	–	–	–													
		Summer		L	P		H						P	P													–	–	–	–	–	–	–
	AT5	Winter		H		L	H		H		–	–	–	–	–	–	–	–	–	–													
		Summer					L		M																		H	H	2	2	H	14	10
Baker Creek	BK1	Winter		L		M	L				L		P		L		L		L	P													
		Summer				L	L																				H	M	4	3	M	4 11,5	21
	BK2	Winter		L		L	L				M				L		M		M		L												
		Summer					M						P	P													H	L	1	3	H	4 11,5	24

Key: L Low use; M Medium use; H High use; V Very High Use; P Species Present but level of use unknown;
– Not sampled. Actual values and details of community types are reported in Holroyd et al, 1979.

techniques that tend to be subjective and highly variable (Whelan et al, 1979).

The techniques used in this project also yield quantitative information on the spatial distribution relative abundance, population densities, and seasonal patterns of distribution for many species. None of these data are available from habitat assessment methods. The incorporation of more rigorous techniques such as mark-recapture and breeding bird grids strengthens the internal accuracy of our information.

Only preliminary statistical tests have been conducted on the accuracy of the land classification for prediction of wildlife distribution. The accuracy of the prediction depends on the relationship between the classification criteria and the variables incorporated into wildlife habitat. A review of the classification in the third year (1977) suggested that some Map Units did not accurately reflect vegetation types that were important to wildlife. For example, Montane alluvial fans were separated by soil type and not by forest type such as aspen, pine or spruce. Recent burns were not separated from older vegetation because of their relative transience and the instructions of the funding agency. The land inventory personnel responded quickly to most of these problems and the 1978 version of the land classification has restructured the classification of Montane fans and has identified burns as an additional mapping category. Map Units now more accurately reflect vegetation types which in turn reflect wildlife values.

A preliminary quantitative analysis was conducted on ungulate pellet group data from two years. The analysis was designed to compare the variability of the pellet data when classified by four variables: elevation, watershed, Map Unit and vegetation type (Table 3). The analysis was hindered by small sample sizes and high sample variance but it tentatively demonstrated that the Map Units and vegetation types were equally useful in predicting the use by six principal components of the pellet data. Watershed was the best predictor and elevation was the worst. Since this analysis was completed, the changes in the land classification mentioned above have improved the meaningfulness of the map unit as wildlife habitat.

The ultimate test of the validity of any data is comparison to a second data set. Using computer techniques the predicted ungulate distribution in the Cascade Valley will be compared to the observed distribution as recorded in range surveys, aerial surveys and random sightings in 1979.

USER CONTACT

CWS staff are located in the parks year-round creating an excellent rapport with Parks Canada staff. During 1978/79 the wildlife inventory information was included in at least 12 studies and reports. Many of these are Environmental Impact Assessments within the National Parks, for example: The Minnewanka Loop Redevelopment, Sulphur Mountain Developments, IA Highway Redevelopment, Pocahontas Warden Station relocation and Hillsdale group camp relocation. The Initial Environmental Evaluations for Lake Louise visitor centre, Marmot Basin Ski area expansion and Trans Canada Highway twinning incorporated the inventory data as did the more intensive Environmental Impact Statement on the Trans Canada Highway twinning.

Wildlife information has been used in special projects such as a goat survey of Slate Range, Lake Louise Planning Study and a study of wildlife mortality on the Trans Canada Highway. Planning at Lake Louise, Egypt Lake, Columbia Icefields and Jasper townsite has required mapping of wildlife data for these areas. Finally wildlife data were used by interpretive staff in the Montane Interpretive Unit plan and the concessionaire program. It should be emphasized that these user contacts all occurred in 12 months.

This intensive use of the wildlife inventory reports points to the great need for quantitative, documented information on wildlife in these National Parks. In all cases the users are cautioned that the inventory is incomplete and conclusions are tentative.

Comments from these users have been very favourable. They have found the inventory data useful and accessible, although often users are personally introduced to the report contents rather than using the reports before seeking help. Feedback on the inventory data and the reports is received in person while the reports are in use. All constructive criticisms are incorporated in the following interim reports and this feedback improves successive reports.

The anticipated applications of the whole inventory have been identified elsewhere (Holland, 1976). A major recent application, as shown above, has been the Environmental Assessment and Review Process documents. Future uses also will include single wildlife species management plans and wildlife monitoring programs.

Table 3: Results of two non-parametric tests on the principal components of the variance in pellet group data. The three components of both winter and summer use account for 90% of the variance in ungulate use (N=359).

Variable	Test	Winter components			Summer components		
		1 (elk)	2 (goat)	3 (deer)	1 (elk)	2 (sheep)	3 (deer)
Elevation	Anova	NS	NS	NS	NS	NS	NS
	K - W	*	NS	NS	NS	NS	NS
Watershed	Anova	***	NS	**	***	NS	***
	K - W	***	NS	**	***	**	NS
Map Unit	Anova						
	K - W	*	NS	*	NS	*	NS
Veg. type	Anova	***	***	**	*	NS	**
	K - W	***	NS	NS	*	*	NS

Significance levels: NS not significant; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

CONCLUSIONS

This wildlife inventory has successfully integrated itself with the biophysical land classification. While the land classification does not meet all of the requirements to map wildlife data at a scale of 1:50,000 it is certainly adequate and more comprehensive than any cartographic classification that could be developed solely by wildlife biologists.

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UTILIZATION OF ECOLOGICAL LAND CLASSIFICATION DATA FOR THE STUDY AND MANAGEMENT OF WATERFOWL RESOURCES IN THE HUDSON BAY LOWLAND

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ABSTRACT

The relationships between habitat and the distribution and densities of breeding Canada Geese were examined using ecological land data. A capability index was derived for each Land System in the study area. Using parameters which control the distribution of habitat types, Land Systems were aggregated into Landscape Units, for which new capability indices were calculated. A positive relationship was found between Landscape Units and breeding densities, but not between Land Systems and breeding densities.

RÉSUMÉ

On a étudié, au moyen de données sur les terres, les relations existant entre l'habitat et la répartition et les densités de population des bernaches du Canada nicheuses. On a pu établir, pour chaque type de terrain étudié, une table des possibilités. Grâce a des parametres contrôlant la répartition des types d'habitat, a rassemblé les types de terrains en unités de paysage pour lesquelles d'autres tables ont été établies. On a trouvé une relation réelle entre les unites de paysage et les densités, mais non entre les types de terrains et les densités.

INTRODUCTION

An Ecological Land Survey is presently underway in the Coastal Zone of the Hudson Bay Lowland, Ontario (Figure 1). The Canadian Wildlife Service, a participant in this work, has undertaken surveys over the past number of years which have shown the coastal zone of the Hudson Bay Lowland to be of major international importance for many species of waterfowl and shorebirds, including those whose existence is either threatened or endangered. The coastline forms an important migrational funnel to and from arctic breeding areas, and inland are substantial breeding populations of waterfowl and shorebirds.

The purpose of the study is to develop an ecologically based classification system for this wetland environment which is both integrative and hierarchical in approach. In undertaking this work it is expected that a better understanding of the nature and development of the wetland environments will result, as will an improved understanding of the relationship between these habitats and major waterfowl and shorebird species of the region.

ECOLOGICAL LAND SURVEY

The Ecological Land Survey (ELS) in the Hudson Bay Lowland comprises a number of research groups undertaking a variety of projects. These include:

(1) an ecological classification group which is developing a classification system for the entire coastal Zone (shore and emergent zones);

(2) a sedimentological/geochemical group which has been undertaking studies in the shore zone of the coast;

(3) a shorebird group which is continuing studies on shorebirds in the shore zone of the coast; and

(4) a waterfowl group concerned with studies on the population and distribution of major waterfowl species in the shore and emergent zones.

The classification work is seen as an integrating force for the project in that it is expected to provide a framework through which the data collected by the various groups can be both ecologically and geographically related.

The classification work consists of two major phases: (1) the classification and (2) the evaluation. This concept which had been previously well documented by Hills, Love and

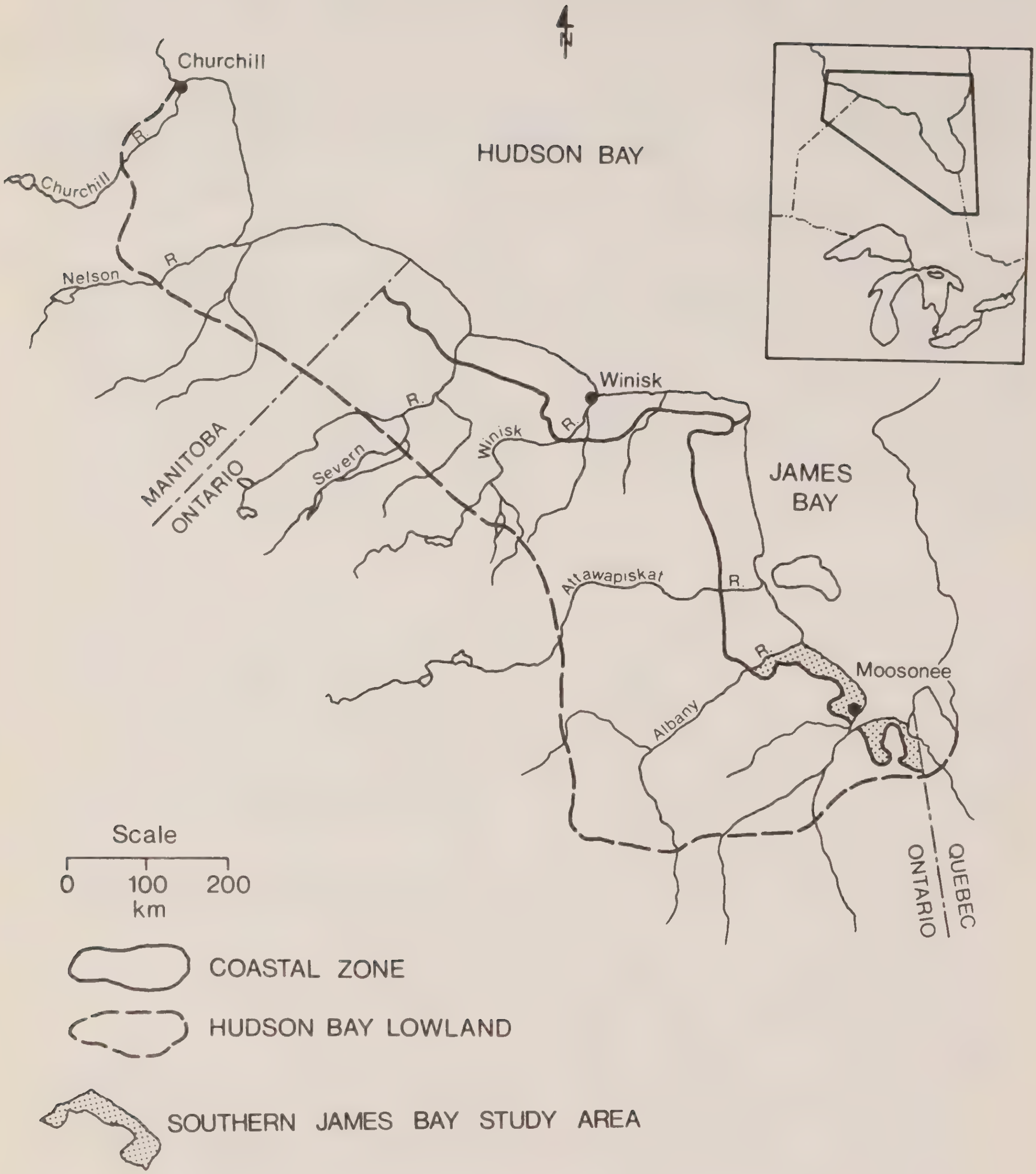


Figure 1: The Hudson Bay Lowland showing the coastal zone boundary.

Lacate (1969), has recently been discussed by the CCELC Lands Directorate (Ecological Land Classification Series Nos. 1 and 7, 1977 and 1979), and reviewed by Wiken (this publication p. 11). The classification, which is hierarchical in nature, attempts to synthesize biotic and abiotic data to form "ecologically significant" landscape units at various levels of generalization. The system as developed to date (Table 1) permits broad levels of generalization as well as more detailed levels. The primary mapping levels include the Region, District, and System. Field studies and detailed site analyses are at the Type and Phase levels. These units provide the framework for the ratings of capability, suitability and other categories of evaluation. As Hills, Love and Lacate (1970) have pointed out, "there are no land evaluation mapping units since the land classification units are used to express the areal occurrence of the evaluation classes or ratings."

AN EVALUATION OF CLASSIFICATION DATA FOR WILDLIFE

To test the possibilities of integrating wildlife data with the basic habitat information provided by the ELC, a special survey of breeding waterfowl was made during the spring of 1978 in the southern James Bay sector which had been classified at the Land System level the previous summer (Cowell et al., 1979). This survey involved a 5% areal sample of the sector using strip transects covered by helicopter (Bell 206A at 100 km/hour and 150 m above ground level). All waterfowl species were identified; however for this paper, only data on the Canada Goose (Branta canadensis) has been used as this species was the most abundant and visible. Applying nesting criteria used in Raveling and Lumsden's (1977) study of Canada Geese breeding in the nearby Kinoje Lakes area (See Table 2), a capability index was derived for each Land System in the study area. This assessment was scaled into the three categories of high, medium and low which have been arbitrarily assigned the exponential values of 4, 1 and 0 respectively for the purpose of producing a numerical index. Survey results showed relatively low numbers of waterfowl in the coastal zone whereas greater densities were observed inland from the Coastal Zone. A total of 51 pairs of Canada Geese were recorded along 566 km of transect. This results in an overall breeding density of $0.45/km^2$. Although this small sample size makes statistical comparisons difficult, an examination of apparent trends is still useful.

Table 1: The five levels of ecological land classification and corresponding mapping scales for the Hudson Bay Lowland coastal zone.

LEVELS OF GENERALIZATION	CHARACTERISTICS	MAPPING SCALE
Land Region (Ecoregion)*	An area of land characterized by a distinctive regional climate and gross hydrologic, vegetative and physiographic regimes.	1:1,000,000
Land District (Ecodistrict)	An area of land characterized by distinctive patterns of physiography and vegetation.	1:250,000 to 1:500,000
Land System (Ecosection)	An area of land characterized by recurring patterns of landform, hydrology and vegetation.	1:100,000
Land Type (Ecosite)	An area of land characterized by a common landform or landform segment and associated vegetation, hydrologic regime and fairly homogenous combination of soils.	1:10,000 to 1:20,000
Land Phase	A landform segment with a common vegetation community and water table regime.	1:2,000

* Equivalent terms adopted by the Canada Committee on Ecological Land Classification - Ed.

Table 2: Criteria used in evaluating Land Systems suitability for nesting Canada Geese.

HABITAT SUITABILITY	WETLAND PATTERN	PERCENT H_2O	HYDROLOGIC TYPE	PHYSIOGNOMIC WETLAND TYPE*
	patterned	5%	ponds with pools	Graminoid Fen with Low Shrub Fen
High	confined	10%	pools with ponds	
	horizontal	20%	pools with ponds	
Medium	patterned	1%	pools with ponds lakes with ponds	Graminoid Fen with Low Shrub Fen
	confined	5%	pools with ponds	Bog systems (low profile vegetation)
	horizontal	5%	pools with ponds	
Low		REMAINDER		

*terminology for wetlands after Jeglum et al (1974).

No relationship between the capability index and the observed breeding density of Canada Geese in each Land System was observed. Using parameters controlling the distribution of habitat types across the coastal zone (vegetation type; hydrologic type and depth of organic material) Land Systems were subsequently combined to form larger, more homogeneous "Landscape Units". New capability indices were then generated for these units using the equation:

$$I_D = \frac{\Sigma(I_s \bullet A_s)}{A_D}$$

where:

I_D = *Landscape Unit Capability Index*

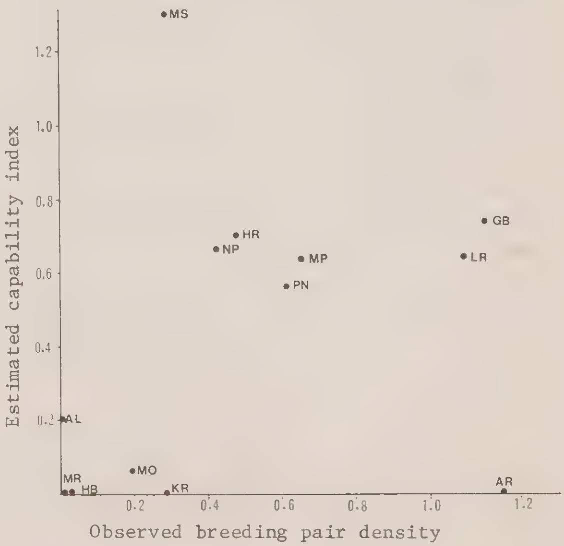
I_s = *System Capability Index*

A_s = *Area of System*

A_D = *Area of Landscape Unit*

In general a positive relationship was found between these Landscape Units and breeding densities (Figure 2). Two units (MR and MS) were apparently not sensitive to the criteria used in developing the Landscape Units. In the case of Landscape Unit AR, which showed no correlation, this is an estuarine dominated area. Normally ice-free early in the spring, higher numbers of geese are probably the result of migrants waiting on or near the estuaries for the opening of nesting habitats further up the coast. Although not conclusive, the results illustrate the problems as well as the successes in correlating ELC and wildlife data. One of the more significant problems arises as a result of fundamental

Figure 2: Observed density versus estimated capability for breeding Canada Geese in Landscape units of the southern coastal zone, Hudson Bay Lowland.



differences in the nature of the information from an ELC and from most wildlife surveys. Using a combination of air photo interpretation techniques and ground sampling, complete areal coverage with a relatively low sampling error (ie relative to the mapping scale is achieved in an ELC project. Wildlife surveys, however, are almost always a small statistical sample often associated with a large variance. This generally results in a large sampling error. Therefore, when such a sample is subdivided among relatively small units such as Land Systems, the variability of the results is usually so great, as in the case of the present study, that relationships become obscured. In general it would appear that waterfowl species perceive their habitat at a finer, more homogeneous level such as the Land Type or even the Land Phase level, depending on the size of the territory or home range maintained. In the case of some waterfowl species such as geese, habitat requirements also shift at different stages in the life cycle. For example, nesting may occur in different habitats than brood rearing and hence separate evaluations may be required for each stage in the life cycle. Moreover, indications are that often avifaunal habitat is 'ecotonal', with species utilizing edge areas between certain combinations of Land Type or Land Phase units.

When the data was aggregated by Landscape Unit, a positive relationship was evident and suggests that given a knowledge of certain habitat requirements, general statements regarding wildlife capability can be made. The larger size of these units permits greater numbers of the given species to be surveyed and therefore sampling error and confidence intervals are reduced. Also the greater size of the Landscape Units and the increased diversity of habitat within them makes these units more self-contained for wildlife. Because the Landscape Units are significantly larger they are also more ecologically distinct from each other; thereby providing an excellent basis for stratifying survey results into subpopulations. It is clear from Figure 3 that the Landscape Units have different population densities of Canada Geese. By segregating these, a reduction in variance can likely be achieved for the total population estimate. Further advantage can be taken if high density units can be predicted and sampling intensity weighted towards them.

Operationally, it was found most useful that CWS biologists be involved in the development of the classification scheme in order to ensure relevance to wildlife needs and to develop common habitat concepts and terminology. These inputs were most effective where there was pre-existing knowledge of the habitat requirements of the various species for which a later evaluation was needed. In this case, the biologists's contribution was particularly valuable in developing hydrological criteria important for nesting waterfowl. Habitat requirements for other species (particularly song birds) are less well known and concurrent studies are being undertaken.

Logistical problems were also present because of the differing methods and timings of field operations. In the Hudson Bay Lowland, breeding waterfowl surveys can take place only during late May whereas song bird surveys must be made during June when the birds are singing. ELC work is preferably carried out during July and August when the vegetation is well advanced. The shoreline process studies and shorebird surveys must also be scheduled for this time although differing field needs make sharing of helicopter time difficult. Field camps, however, can be successfully co-located.

SUMMARY

In summary, it has become clear that the integrating of wildlife data into the ELC for the Hudson Bay Lowland coastal zone was inappropriate at the Land System level. However by interpreting selected ecological parameters within each Land System new "Landscape Units" can be formed which have been found useful in evaluating wildlife capability for those species such as geese where adequate background information was available. Of greater importance is the implication that the units developed using an ELC data base, provide a useful stratification basis for the usually extensive waterfowl surveys. Logistical integration of the various wildlife surveys, shoreline process studies, and the ELC is problematic because of differing schedules and methods. All facets of the program require considerable independence although several can take place concurrently from the same camp.

FUTURE WORK

An intensive project involving work at the Land Type level is planned for the Snow Goose colony and surrounding area at Cape Henrietta Maria during the summer of 1979. Large-scale aerial photography (colour and colour I.R.) will be flown during late June at the same time as the B & W coverage which will be used in counting the number of nesting pairs of Snow Geese. The classification will provide information on the area available for potential expansion of the colony, and therefore on limits of population size, for the proper management of this species.

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MAPPING CRITICAL WILDLIFE HABITAT IN AGRICULTURAL SASKATCHEWAN

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ABSTRACT

Critical wildlife habitat is mapped throughout agricultural Saskatchewan. Habitat recognition involves evaluation of current regional wildlife population levels and distributions as influenced by variation in climate, soils, landforms, vegetation, land use, and land tenure. Information is presented on 1:250,000 NTS map sheets and in accompanying reports.

RÉSUMÉ

Les habitats vitaux de la faune ont été cartographiés à la grandeur du territoire agricole du Saskatchewan. Leur inventaire comprend l'évaluation, par region, de l'importance et de la répartition des populations fauniques actuelles selon le climat, les sols, les formes de terrain, la végétation, l'occupation des sols et le régime foncier. Les données sonts présentées sur des cartes du SNRC, a l'echelle de 1:250,000 et dans les rapports qui leur sont joints.

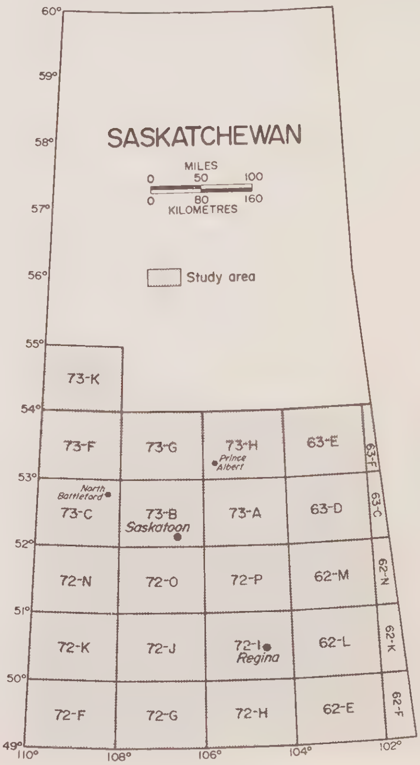
BACKGROUND AND OBJECTIVES

The Terrestrial Wildlife Habitat Inventory was initiated in 1975 by the Wildlife Research Division of the Saskatchewan Department of Tourism and Renewable Resources. This research program was developed in response to increased agricultural development pressures, as well as demands for a quantification and priorization of the wildlife habitat resources remaining in southern, agricultural Saskatchewan.

Highly mechanized and efficient clean-farming practices have resulted in rapid declines in the amount of natural vegetation suitable for supporting indigenous wildlife species. Land previously unfeasible for cultivation or drainage is now readily developed. During the 25-year period from 1951 to 1976 the unimproved portion of occupied farmland declined by 23% (0.9%/annum), from 37.1% in 1951 to 28.5% in 1976 (Agricultural Census Statistics for 1951 to 1976, Gov't. of Canada). This trend appears to be continuing in spite of the fact that more than 70% of agricultural Saskatchewan is already intensively developed.

The Inventory is designed to provide a regional reconnaissance perspective of current wildlife habitat characteristics and use as reflected in major variations in the biophysical and cultural attributes of the landscape. The study area encompasses all of agricultural Saskatchewan and includes 21 1:250,000 NTS map sheets (Figure 1). The approach is relatively simple and practical. It is designed to be readily useable by wildlife managers and land use planners who may have little or no background

Figure 1: Map regions to be surveyed by the Terrestrial Wildlife Habitat Inventory.



in ecological land surveys.

METHODOLOGY AND INFORMATION PRODUCTS

A four-part map series depicts physical land systems, present land use, land tenure and critical wildlife habitat at the 1:250,000 map scale. The Land System map is produced in color and may serve as a base map with the other three presented as transparent overlays. These latter three maps are also produced as paper blueprints and make useful field copies. The mapping methodology is described in some detail in Hart et al (1979) and the land system and land use classes are defined in Appendices I and II. Selected land systems and land use classes in southeastern Saskatchewan are illustrated in Plates 1 - 6. A written report accompanies each map package and describes habitat characteristics and ecological relationships, as well as presenting some general habitat management recommendations.

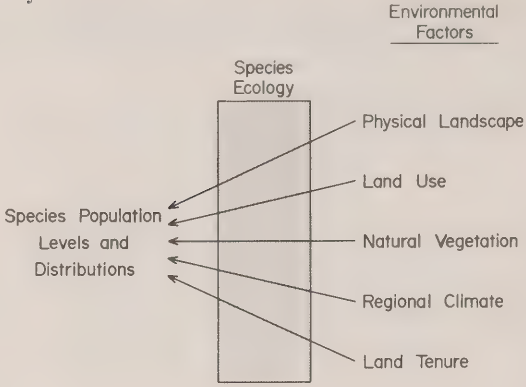
The Terrestrial Wildlife Habitat Inventory is being conducted by a team of three full-time ecologists who bring together expertise in terrain evaluation, land use, plant ecology and wildlife biology. Heavy reliance is placed on existing sources of data, primarily soil survey and geology maps and reports, air photo interpretation of 1970 LIFT photos (B & W, 1:80,000), government records and reports, plus available published literature. Only 10 - 20% of an ecologist's time is devoted to gathering additional field data.

MAPPING CRITICAL WILDLIFE HABITAT

Critical wildlife habitat is defined as those areas which are by far the best within a map region (1:250,000 NTS map sheet) and most essential for maintaining current populations of a particular species. A loss of critical habitat would result in major permanent declines in populations. Wildlife species of primary consideration are upland game birds and ungulates, although critical habitat may also be identified for other wild vertebrates (excluding fish) for which there is sufficient knowledge in a given region. Particular attention is paid to regionally unique, rare or endangered species.

The identification, mapping and description of critical habitat involves an analysis of population levels and distribution as influenced by variation in physical landscape, land use, natural vegetation, regional climate and land tenure (Figure 2). This analysis results in the identification of key habitat factors which can be used within regional climatic zones to map critical areas, even where population data is not available. Not only must the key habitat parameters be identified but also the optimal mix of those parameters under varying environmental conditions.

Figure 2: Key habitat parameters are identified as a result of analyzing population levels and distributions in light of variation in environmental factors.



The mapping process is quite subjective and utilizes all available data on population densities and distributions, species ecology and known regional habitat preferences. The biophysical and cultural components of the Inventory provide the necessary framework within which some objectivity can be employed in standardizing the recognition, delineation and description of critical wildlife habitats. By way of example, an analysis of winter white-tailed deer population densities is given. These surveys were conducted in January and February of 1978 throughout representative portions of three map sheet areas in southeastern Saskatchewan (Yorkton-Duck Mountain, 62M-62N; Melville-Riding Mountain, 62L-62K; and Weyburn-Virden, 62E-62F, Figure 1). An aircraft was used to search out selected parcels of land ranging in size from 0.6 km^2 to 5.2 km^2 to obtain estimates of total numbers of deer. Samples were stratified by land system, land use, and natural vegetation cover and approximately 260 km^2 of land were surveyed within each 19,425 km^2 map area.

Highest deer densities for the two southern map areas were found on lands within the Moraine, Eroded, Meltwater Channel and Drainage land systems (Table 1). In the most northerly map area (62M - 62N) very little variation occurs in average density between the land systems surveyed. Also the lowest average winter density of 3.6 deer/km^2 occurs on this north-

Plate 1: *An underfit prairie stream (D) occupies a glacial meltwater channel (MC) and they are mapped as a complex because of scale and the intimate association of the two. Glacial fluvial-lacustrine (FL) deposits form the surrounding landscape.*

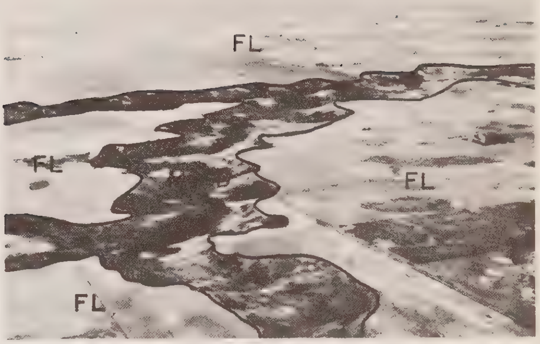


Plate 2: *The Souris River Valley is formed by a glacial meltwater channel (MC) and includes eroded (Er), drainage (D) and alluvium (Av) land systems. Moraine (M) borders the valley.*

Plate 3: *A typical land use pattern in the aspen parkland of southeastern Saskatchewan. Land use class 4 is depicted on a low relief moraine.*

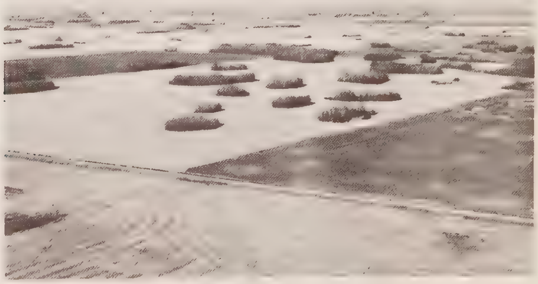


Plate 4: Marginal farming activity in hummocky, high relief moraine. Land use class 2 is represented.

Plate 5: Land use class 1 and vegetation cover class D is shown by native prairie on the Missouri Coteau.

Plate 6: A diversity of woody and herbaceous natural vegetation covers this high relief, hummocky moraine. Land use class 1 and vegetation cover class C is shown.

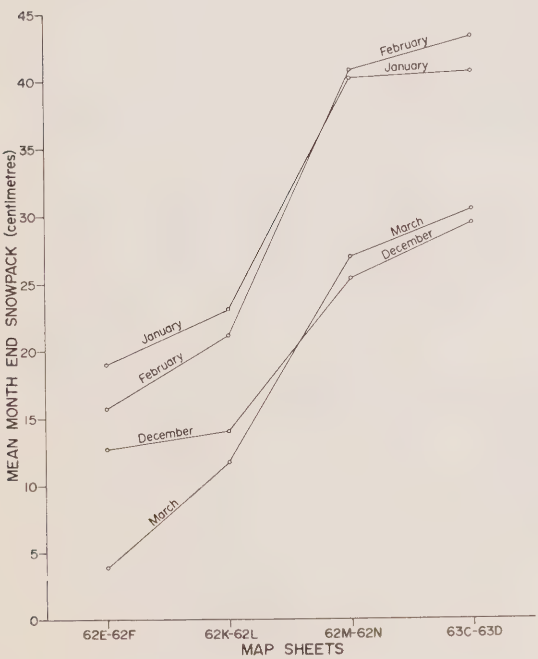
Table 1: Winter (1977-78) white-tailed deer densities (deer/km^2) with respect to variation in physical landscape characteristics.

	MAP SHEETS		
LAND SYSTEM*	62M - 62N	62L - 62K	62E - 62F
Moraine (M)	3.7	6.9	17.2
Washed Moraine (WM)	-	-	14.0
Fluvial (F)	3.7	1.9	9.6
Fluvial-Lacustrine (FL)	-	2.0	-
Solonetzic Soil (Sol)	-	-	8.5
Eroded (ER)	-	8.3	7.8
Meltwater Channel (MC)	3.9	6.6	14.4
Drainage (D)	1.3	-	13.9
All Land Systems Surveyed	3.6	5.9	13.9

* See Appendix I for definitions of land systems.

ern map area. An analysis of historical winter snow pack data from the three map regions suggests that significantly higher average snow depths in the northerly map sheet may be keeping population levels depressed (Figure 3). This means that habitat relationships which appear to be applicable in the south may be quite different only 120 to 240 km further north.

Figure 3: Mean snowpack (1951-76) to month end for selected locations in southeastern Saskatchewan.



At present natural vegetation cover is not mapped because in agricultural Saskatchewan the units would be very small, fragmented and in many cases unmappable at a 1:250,000 map scale. However, vegetation cover characteristics are still a most important habitat feature and are checked on photos and in the field, and are subsequently described in the written report. The 1978 deer survey data were also analyzed with respect to four broad vegetation cover types defined in Appendix III . Appreciably greater utilization of areas with a predominantly tree and tall shrub cover occurred in all three map regions (Table 2). Fairly good utilization of areas dominated by grassland and low shrubs was found only on the most southerly map region (62E - 62F) which has the mildest winter conditions. Even on the most northerly map area (62M - 62N), deer appeared to prefer areas with some openings in the tall woody cover (Vegetation Cover Class B). This preference would presumably be important in providing an optimal balance between shrubby browse and taller thermal cover species.

Table 2: Winter (1977-78) white-tailed deer densities (deer/km^2) with respect to variation in natural vegetation cover.

	Map Sheets		
Vegetation Cover Class*	62M-62N	62L-62K	62E-62F
A	3.4	6.9	19.9
B	4.6	6.9	18.3
C	1.0	5.1	14.4
D	-	0.0	10.0

* See Appendix III for definitions of Vegetation Cover Classes.

An analysis of deer densities and land use classes shows highest deer densities occurring within Land Use Class 2 on the two southern map areas (Table 3). This suggests that a small amount of farmland mixed in association with areas of natural vegetation provides desirable deer habitat. In fact considerable depredation of agricultural crops (primarily hay) does occur during the winter season in these areas.

The foregoing provides just one example of how a population data base can be manipulated to provide insight into animal-habitat relationships which need to be understood before critical areas can be delineated. At a reconnaissance level of mapping only superficial, small scale relationships can be developed and heavy reliance must be placed on existing population survey data. Unfortunately, most provincial game management surveys are designed only to provide annual population trend data and the results can seldom be keyed to specific habitat features. For this reason ecological land surveys must consider at the outset what additional population surveys may have to be conducted in order to incorporate a meaningful wildlife component into the data base.

Table 3: Winter (1977-78) white-tailed deer densities (deer/km^2) with respect to variation in land use.

Land Use Class*	Map Sheets 62M-62N	62L-62K	62E-62F
1	3.9	6.3	13.5
2	2.8	7.8	18.9
3	2.9	2.4	12.9

* See Appendix II for definition of Land Use Classes.

INTEGRATION OF INFORMATION PRODUCTS

Integration of the components of the Inventory is achieved in two ways. First, the four map products can be visually interpreted in an overlay format, allowing rapid comparison of critical wildlife habitat with land use, land tenure and land system characteristics. Second, the written report describes in detail the key parameters used in identifying and delineating critical habitat for each species. General habitat capabilities and limiting factors are discussed for all noteworthy wildlife species under each land system. This provides a useful sketch of the ecological relationships that exist between a particular wildlife species and the various environmental components considered by the Inventory.

Charts can be useful in summarizing some of the general relationships that exist between a wildlife species and various environmental components identified. To illustrate, several wildlife species occurring on the 62E - 62F map area are correlated in summary fashion with variation in land systems, natural vegetation cover, and land use (Tables 4 - 6). In this way the relative importance of various environmental factors is illustrated and in combination general habitat features begin to appear. It must be emphasized, however, that these correlations are subject to change in different climatic, vegetation and geographic regions.

Table 4: Wildlife-land system relationships on the 62E-62F map sheets in southeastern Saskatchewan.

	Land Systems											
	M	M(h)	WM	F	FL	L	Sol	Er	MC	D	Av	Sa
White-tailed Deer	+	+	+					+	+	+		
Moose		+						+				
Elk		+						+				
Ring-necked Pheasant	+									+		
Ruffed Grouse	+	+						+	+	+		
Sharp-tailed Grouse	+	+	+	+				+	+	+		
Beaver	+	+							+	+		
Great Blue Heron		+							+	+		
Painted & Snapping Turtle										+		

+ Strong positive relationship + Moderate positive relationship

Table 5: Wildlife-vegetation cover relationships on the 62E-62F map sheets in southeastern Saskatchewan.

	Vegetation Cover Classes trees ← → grass			
	A	B	C	D
White-tailed Deer	+	+	+	
Moose	+	+		
Elk	+	+	+	
Ring-necked Pheasant			+	+
Ruffed Grouse	+	+		
Sharp-tailed Grouse		+	+	+
Beaver	+	+		
Great Blue Heron	+			
Painted & Snapping Turtle	N/A	N/A	N/A	N/A

Cover Class	Tree & Tall Shrub Cover	Grass & Low Shrub Cover
A	75-100%	0-25%
B	50-75%	25-50%
C	25-50%	50-75%
D	0-25%	75-100%

+ Strong positive relationship

+ Moderate positive relationship

Table 6: Wildlife-land use relationships on the 62E-62F map sheets in southeastern Saskatchewan.

	Land Use Classes 90-100% native ⟵⟶ 0-10% native				
	1	2	3	4	5
White-tailed Deer	+	+	+	+	
Moose	+				
Elk	+	+			
Ring-necked Pheasant	+	+	+	+	
Ruffed Grouse	+	+			
Sharp-tailed Grouse	+	+	+	+	
Beaver	+	+	+		
Great Blue Heron	+				
Painted & Snapping Turtles	+				

+ Strong positive relationship

+ Moderate positive relationship

Considerably more integration, particularly of a quantitive nature, could be achieved if our map products were incorporated into, and manipulated by, the Canadian Geographic Information System. This would allow a rapid quantification of various overlay combinations, as well as providing the opportunity to insert new and up-to-date information.

APPLICATIONS

The Inventory products are being requested for many purposes including land use planning, environmental impact assessment, and wildlife management and research. Critical wildlife habitat maps identify key parcels of land requiring special management and protection strategies. The Inventory as a whole provides a common meeting ground upon which various resource specialists can more effectively communicate their needs and concerns. It may also serve as an educational tool whereby broad ecological relationships can be effectively illustrated and explained to students.

GENERAL COMMENTS REGARDING ECOLOGICAL LAND SURVEYS HAVING A WILDLIFE COMPONENT

1. Ecological land surveys form the logical framework within which a wildlife habitat mapping program may be conducted. However, such surveys should consider cultural, as well as physical and biological features if current habitat capability and value is to be recognized.

2. The wildlife biologist should be involved at the very beginning of an ecological land survey to ensure that physical landscape, water, vegetation and land use categories are likely to reflect significant variations in wildlife habitat characteristics. Initially, the species of wildlife to be considered, and the primary habitat factors likely to be important, must be identified within the survey region. Only then can the wildlife biologist have meaningful input into the biophysical categories to be used within a particular ecological land survey.

3. Wildlife populations are highly variable and may not reflect habitat quality and importance in the short term. Regions for which little or no wildlife data exist will require at least two to three years to gather adequate baseline information before meaningful interpretation of habitat characteristics and capabilities can be achieved. Considerable caution must be exercised when inferring population - habitat relationships from other studies which were conducted in different geographic, climatic or vegetation regions.

4. The biophysical, cultural and wildlife components of an ecological land survey should be presented as separate map entities that can still be integrated in an overlay and descriptive fashion. The production of one integrated map product would be too detailed and confusing, and may result in the elimination or masking of some information. Separation of components permits greater flexibility of use and more opportunity for re-interpretation and modification based on different assumptions or new information.

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APPENDICES

Appendix 1: Definitions of Land Systems

This is a land classification that strongly reflects land genesis, but is not in all cases defined strictly according to it.

The map scale and reconnaissance nature of the classification have combined to prohibit the establishment of map units smaller than approximately 2.6 km^2, and narrower than approximately 0.4 km.

Low and high relief phases of some land systems

are recognized, however, only the high relief (h) map units are symbolized. Low relief lands approximate the flat to gently rolling topographic classes of the Soil Survey, while the high relief phase includes the gently to strongly rolling classes.

MORAINE: Lands formed predominantly by unsorted glacial deposits (till), comprising undulating plains, "knob and kettle" terrain and other topographic variations.

WASHED MORAINE: Lands formed by till deposits superficially washed by glacial meltwaters, frequently resulting in a high proportion of coarse materials at the surface.

FLUVIAL: Lands formed by coarse textured (sandy) to gravelly), glacio-fluvial deposits.

FLUVIAL-LACUSTRINE: Lands formed by glacial, fluvial-lacustrine, sandy deposits.

LACUSTRINE: Lands formed by fine textured (mostly silt and clay), glacio-lacustrine deposits.

AEOLIAN: Lands formed by glacial sand deposits subsequently reworked by wind; high relief phase characterized by dunes.

SOLONETZIC SOIL: Lands characterized by solonetzic soils (hard, compact subsoils). Some areas possess microrelief due to shallow "burn-out" pits.

ERODED: Strongly dissected lands mostly adjacent to major valleys and on escarpments; also includes areas of slumping.

MELTWATER CHANNEL: U-shaped valleys comprising glacial meltwater channels and spillways, frequently characterized by eroded walls, alluvial and/or saline alluvial deposits, lakes and streams.

DRAINAGE: Complex assemblages of land associated with usually meandering streams. Comprises various alluvial deposits and other features of active floodplains and associated valleys.

ALLUVIUM: Lands formed largely by fine textured alluvial deposits; frequently flat and poorly drained.

SALINE SOIL: Lands characterized by soils with high concentrations of soluble salts (alkali soils); flat to depressional, poorly drained.

FEN: Organic land formed by a thick accumulation of primarily sedge-peat enriched by circulation of slow moving, slightly acidic to alkaline soil-water.

BOG: Organic land formed by a thick accumulation of sphagnum moss-peat, associated with stagnant, nutrient-poor water which is strongly acidic.

BEDROCK: Lands exhibiting strong physical bedrock control, mostly characterized by a thin mantle of glacial deposits, dissection, highly variable relief, high elevations and bedrock exposures. Various categories of this broadly defined land system are recognized.

Appendix II: Definitions of Land Use Classes

Land use was classified using 1970 LIFT aerial photographs. The classification of Class 1 lands was brought up-to-date by extensive aerial reconnaissance in 1977. The five land use classes are defined according to the proportion of total area supporting native vegetation and introduced perennial forage crops. In classes 1-4, the ratio of native vegetation to introduced perennial forage crops is at least 3:1, except where otherwise indicated by letters representing subclasses. Class 5 units are not sub-classified.

For the purposes of this classification, land includes uplands plus wetlands which are temporarily inundated.

<u>Class 1</u> - 90-100% of the land supports native vegetation and/or introduced perennial forage crops. The remaining 0-10% is used to produce annual crops, and/or for other purposes not entailing native vegetation or introduced perennial forage crops.

<u>Class 2</u> - 50-90% of the land supports native vegetation and/or introduced perrennial forage crops. The remaining 10-50% is used to produce annual crops, and/or for other purposes not entailing native vegetation or introduced perennial forage crops.

<u>Class 3</u> - 30-50% of the land supports native vegetation and/or introduced perennial forage crops. The remaining 50-70% is used to produce annual crops, and/or for other purposes not entailing native

vegetation or introduced perennial forage crops.

Class 4 - 10-30% of the land supports native vegetation and/or introduced perennial forage crops. The remaining 70-90% is used to produce annual crops, and/or for other purposes not entailing native vegetation or introduced perennial forage crops.

Class 5 - 0-10% of the land supports native vegetation and/or introduced perennial forage crops. The remaining crops, and/or for other purposes not entailing native vegetation or introduced perennial forage crops.

SUBCLASSES

N-T The ratio of native vegetation to introduced perennial forage crops is less than 3:1 but at least 1:1.

T-N The ratio of native vegetation to introduced perennial forage crops is less than 1:1 but at least 1:3.

T The ratio of native vegetation to introduced perennial forage crops is less than 1:3.

Example

2-N-T The class (2) indicates an area of land comprised of 50-90% native vegetation and introduced perennial forage crops. The subclass (N-T) indicates the ratio of native vegetation to introduced perennial forage crops is at least 1:1 but is less than 3:1.

Appendix III: Definitions of Vegetation Cover Classes.

Cover Class	Trees & Tall Shrubs	Low Shrubs & Grassland
A	75-100%	0-25%
B	50-75%	20-50%
C	25-50%	50-75%
D	0-25%	75-100%

INTEGRATING WILDLIFE AND BIOPHYSICAL LAND INVENTORIES IN THE NATIONAL PARKS OF ATLANTIC CANADA

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ABSTRACT

Mammal inventories were conducted before, during, and after biophysical inventories in the Atlantic Region national parks. This paper discusses the problems and advantages associated with each of these approaches. The most effective integration of information occurred when mammal studies were carried out after the biophysical inventory had been done. Various examples of the integration of wildlife and biophysical information are presented. Vegetation type and forest canopy composition were found to be the most significant habitat characteristics for most mammals studied and ecosections proved to be the most useful sampling units for the majority of species studied.

RÉSUMÉ

Des dénombrements de mammiferes ont été faits avant, pendant et apres des inventaires biophysiques dans les parcs nationaux de la région atlantique. Le présent document analyse les inconvénients et les avantages de chaque méthode utilisée. Les résultats ont démontré que la plus efficace était celle qui suit l'inventaire. Divers exemples de l'integration des informations sur la faune et des données biophysiques sont présentés. L'analyse a révélé que le type de végétation et la composition des especes constituant le couvert forestier sont les caractéristiques de l'habitat les plus importantes pour ce qui est des mammiferes étudiés; les ecosections se sont révélées les unités d'échantillonnage les plus utiles pour ce qui concerne la majorité des especes inventoriées.

INTRODUCTION

Biophysical Land Inventories were initiated in the national parks of the Atlantic Region in 1971. These studies have now been completed in all seven parks (Table 1). Wildlife inventories for both birds and mammals began in Kouchibouguac and Kejimkujik National Parks in 1971 and in Cape Breton Highlands National Park in 1974. Mammal inventories are now being conducted in Prince Edward Island, Gros Morne and Terra Nova National Parks. The Canadian Wildlife Service has carried out all Atlantic Region mammal inventories except in Kouchibouguac and supervised three of the avifauna surveys. Mammal inventories were conducted before, during, and after biophysical inventory data was available. Only the mammal inventories will be referred to in this paper. The objective of this paper is to discuss some of the problems involved in integrating wildlife and biophysical inventories when the wildlife inventories are conducted before, concurrent with, and after the biophysical inventories.

INTEGRATION OF WILDLIFE WITH BIOPHYSICAL LAND INVENTORIES

Before the Biophysical Land Inventory

Until recently, most wildlife studies and inventories have proceeded without the benefit of ecological or biophysical land inventories. Biologists often had to depend on any available, usually inadequate, habitat information or devise their own habitat classification, usually a forest cover type map. Many investigators gathered excessive amounts of descriptive information on habitat which was often never or poorly used. The habitat descriptions associated with the earlier wildlife inventories conducted in Atlantic National Parks were undertaken in that manner. However, when the time came to integrate the wildlife or mammal inventory information into an ecological or biophysical land inventory (BLI) carried out later, the criteria recognized for a "wildlife habitat" by the biologist differed, sometimes widely, from the criteria recorded by the BLI teams. For example, a small mammal inventory was conducted in Cape Breton Highlands in 1974 and 1975 before the BLI was started. Twenty mammal "habitats" were compared with 24 vegetation types (Table 2), the closest equivalent to habitat types delineated by the BLI (Eastern Ecological Research Ltd., 1978). Information on the mammal habitats proved inadequate for correlation with the vegetation types of the BLI system, and further small mammal inventory work is required. A similar problem was encountered in Kouchibouguac and Kejimkujik National Parks, which also had wildlife inventories done prior to BLI's.

Concurrent with the Biophysical Land Inventory

Integration was somewhat more successful when wildlife and BLI programs were carried out concurrently in Cape Breton Highlands National Park. Preliminary BLI maps, ie maps that

Table 1: Status of biophysical land and wildlife inventories in Atlantic Region national parks.

National Park	Area (km^2)	Contractor	Detail	Scale of Mapping	Completion Date	Wildlife Inventory (Completion Date) Mammals	Birds
Gros Morne	1911	Airphoto Analysis Associates Consultants Ltd., Toronto	Land Type	1:25,000	1975	1980	1976
Kejimkujik	375	Forest Management Institute, DOE, Ottawa	Land Phase	1:12,500	1975	1975	1973
Kouchibouguac	223	Atlantic Resource Planners, Fredericton	Land Type	1:12,500	1975	1972	1974
P.E.I.	18	Eastern Ecological Research, Truro	Land Type	1:15,000	1976	1980	1979
Fundy	414	Forest Management Institute, DOE, Ottawa	Land Phase	1:12,500	1976	1978	1980
Terra Nova	388	Gauthier, Poulini, Theriault Ltd., Ste-Foy	Land Type	1:15,840	1977	1978	1979
Cape Breton Highlands	935	Eastern Ecological Research	Land Phase	1:15,600	1978	1979	1979

Table 2: Comparison of habitat types delineated prior to biophysical land classification with vegetation types described by the biophysical land inventory program.

Habitat Types	Vegetation Types	Habitat Types	Vegetation Types
Softwood forests	Hemlock Balsam fir, black spruce White spruce Black spruce Balsam fir	Hardwood floodplain	White spruce, balsam poplar, white birch
		Spruce-fir-heath association	Dwarf black spruce
Jack pine	Jack pine	Dry heath barren Salt spray barren	Barrens
Mixed wood forests	Balsam fir-tolerant hardwoods Spruce, fir, pine-intolerant hardwoods Balsam fir, white birch White birch, balsam fir White spruce, white birch, pin cherry	Black spruce bog	Sphagnum mire
		Wet heath barren Bog meadows Floodplain meadows Salt marsh Stream banks River banks Lake shores	Sedge mires
Hardwood forests	Beech Sugar Maple White birch, yellow birch Red maple	Talus slopes	Talus
		Old fields	Fields
		Rocky shore Roadside	Miscellaneous
Birch-aspen fire succession	White birch, trembling aspen, red maple		

were made from aerial photograph interpretation only, were used to establish the initial wildlife sample locations. When the maps were ground checked some changes occurred, such as boundary or forest cover composition changes, which seriously affected the adequacy of the wildlife sample. Such changes can be especially serious in a short-term inventory program which limits re-sampling. Attempts at modifying the BLI field crew's data collection techniques to include collection of wildlife data such as browsing, pellets, and tracks proved somewhat successful. However, the results were restricted by limited manpower and time, and the BLI crew's primary objective of ground checking their aerial photo interpretation. They usually did not sample the more easily identifiable vegetation types or types that were not "typical" and tended to avoid ecotones which adversely affected the adequacy of the sample for determining wildlife distribution.

The main problem with concurrent inventories is the lack of a readily available and reliable information base on which to design a wildlife inventory program. Preliminary maps are just that - preliminary. They are subject to change and are usually available only at land type or phase level, ie, direct from aerial photographs. There are few summaries or analyses of the BLI data available at that stage. For example, identification of the major vegetation types and the relative proportions of vegetation types were not made. That information is essential in order to design adequately representative surveys to determine wildlife distribution.

After the Biophysical Land Inventory

The most successful integration of wildlife and biophysical land inventories took place when the wildlife inventory was carried out after the BLI, such as occurred in Gros Morne, Terra Nova, and Fundy National Parks, and in particular when the BLI was designed in conjunction with wildlife biologists such as with the later stages of the Cape Breton Highlands National Park inventory. The best results were obtained when a close working relationship between the BLI crew and the wildlife biologist was formed in the preliminary planning stages of the BLI. The wildlife biologist must be able to clearly specify his requirements for determining wildlife habitat characteristics.

IDENTIFICATION OF WILDLIFE HABITAT REQUIREMENTS

One approach to identifying basic wildlife habitat requirements is illustrated in Table 3. Some of the major wildlife habitat components that influence the distribution of individual species or species groups were ranked on a scale of 0 to 5. The species grouping was arbitrary and some difficulty was encountered in combining some diverse groups such as shrews. The influence of the habitat component was ranked regardless of whether it had a positive or negative effect. The habitat component evaluations in this example were subjective and based on experience with the distribution of the mammals and wildlife habitats in the Atlantic region. Numerical values can be substituted for the ranked values by using the results of wildlife inventory programs. Whether those numerical values can be extrapolated from land type to land type within each Park or from Park to park is questionable, and depends greatly on the characteristics of the areas involved.

This method is not necessarily the best or the only approach to determining important wildlife habitat components. However, it is a useful exercise in several ways. It points out obvious gaps in our knowledge of wildlife habitat requirements; it requires decisions on relative values of habitat components to wildlife service; and perhaps, most importantly, it provides justification why certain components of the habitat should be measured in the BLI.

In the example (Table 3), the component having the highest average value was canopy composition, and shrub layer composition. Besides snow accumulation, all the important components of the habitat are vegetation characteristics. The major components of wildlife habitats that were recorded in the BLI's of the seven Atlantic National Parks are shown in Table 4. Clearly, the BLI's lack specific data on climate and details of shrub and ground vegetation both of which are significant to wildlife. Those topics are usually treated in a more general fashion for the Park as a whole and not normally incorporated into the land type descriptions. In general, the summaries for those components in the BLI's of most of the Atlantic National Parks are adequate for general mammal and habitat evaluations, except for information on snow. Snow accumulation plays an important role in the winter survival and distribution of most eastern mammals. Average mid-winter snow cover varies from 0.2 m to over 3 m in various parts of Atlantic Canada, however, it can vary significantly over very short distances. Unfortunately, snow accumulation information is not usually recorded at standard meteorological stations, which are often poorly located for purposes of extrapolation to more remote areas. Collecting snow information is a long-term program and not suited for most standard BLI's.

Table 3: Relative values of various habitat descriptive factors that influence mammals in their choice of habitats.

INFLUENTIAL HABITAT FACTORS	SPECIES GROUPS																										
	Shrews	Moles	Bats	Snowshoe Hare	Arctic Hare	Squirrels	Beaver	Mice & Voles	Muskrat	Porcupine	Coyote	Fox	Black Bear	Raccoon	Weasel	Marten	Otter	Mink	Lynx	Bobcat	Caribou	White-tailed Deer	Moose	AVERAGE	moderate	strong	very strong
Abiotic																											
Geology		1	1				1		2															0.2	–	–	–
Surficial Materials		2				1	2	1	3		2	2	1											0.6	1	–	–
Soil Type	1	5				1	2	2	2		1	2										1		0.7	–	–	1
Topography	2	4	1	1	4		4	1	4					2		1	2	1	1		3	3	1	1.5	2	4	–
Aspect	1			1	1	1		1		1											2	4	3	0.7	1	1	–
Slope	2	2		2	3		4	2	4								2	1			2	4	3	1.3	2	3	–
Drainage	3	4				1	3	2	4				1	2			1	1			2	2	2	1.2	2	2	–
Climate –																											
season length	1	2	1	2	2	2	4	3	3	1	1	1	2	3	1	1	2	1	1	1	2	3	2	1.8	4	1	–
wind			1	3	4					1	1	1				1			1	1	2	3	2	0.9	2	1	–
snow	3	2		3	3	2	2	4	3	2	2	2	1	2		3	1	2	2	3	4	4	2	2.3	4	4	–
rain	1	1			2		3	1	2											1	1	1		0.6	1	–	–
temperature	2	1	3	2	1	4	4	2	4	1			2	3			3	2	2	2	1	3	1	1.9	4	3	–
Biotic																											
Vegetation –																											
Canopy-Composition	3	1	2	3	3	4	4	3		4	1	2	1	2	2	3	1	1	2	2	1	4	3	2.7	6	4	–
Density	2		3	3	4	2	3	4		1	1	2	3	3	2	4		1	2	1	4	3	2	2.2	6	4	–
Height	1			2	2	3	2	3		3				3	1	4			2	1	2	3	2	1.5	5	1	–
Shrub-Compositions	2	1		4	4	2	3	3		1	1	1	3	1	2	2		1	3	3	3	4	4	2.1	5	5	–
Density	2			4	2	2	2	2			1	1	2	1	2	2		1	3	3	2	3	2	1.6	4	1	–
Ground Cover–																											
Composition	4	3		3	3	2	3	4	4	2			2	2	2	2		1	2	2	5	3	1	2.2	5	3	1
Density	3	3		3	2	1	2	4	2	2			2	2	3	1		2	1	1	3	2	1	1.7	4	1	–
Insects & Invert.	4	5	5			1		3					2	3	3	2	1	2						1.3	3	1	2
Fish		1											2	2			5	4						0.6	–	1	1
Birds	2			2		2		2			2	2		2	1	3	1	2	2	2				1.1	1	–	–
Reptiles-Amphibians	1													2	1	1	2	1						0.3	–	–	–
Other Mammals	2	2		1	2	2	2	2	2	1	4	4	1	1	4	4		2	4	4	1	1		2.0	–	6	–
Human history –																											
exploitation				1	2		3		3	1	1	1	1			4	4	1	4	1	5	2	4	1.7	2	4	1
land use	2	3	2	3		1	2	2	3	1	3	3	2	2	2	4	1	1	3	2	2	3	2	2.1	7	1	–
Disturbance –	2	3	3	2	3	2	3	1	3	1	2	1	2	1	1	4	3	1	3	2	3	2	3	2.2	9	1	–
Type Size	1	2		1	2			1		1				1		4			3	1	4	2	1	1.0	1	2	–
Vegetation diversity	2	1	1	3	1	1	3	2	1	2	2	2	3	1	2	4	1	1	2	2	2	3	2	1.9	4	1	–
Successional stage	2			4	2	1	2	2	2				3	1		4			3	2	4	3	2	1.6	3	3	–
Proximity to Water	3	3	3				5		5					3			5	4				2	3	1.6	5	1	3

Strength of influence: 0 – none; 1 – very weak; 2 – weak; 3 – moderate; 4 – strong; 5 – very strong

Table 5: Wildlife inventory programs carried out in the national parks of the Atlantic Region from 1972 to 1979.

PROGRAM	Gros Morne	Kejimkujik	Kouchibouguac	P.E.I.	Funday	Terra Nova	Cape Breton
Winter							
Aerial Ungulate Surveys	●	●	●		●	●	●
Track Transects	●			●	●	●	●
Porcupine Survey					●		
Tracking Programs				●		●	●
Ungulate Conc. Area location					●	●	●
Snow Monitoring Programs	●		●	●	●	●	●
Spring							
Muskrat Pushup Counts				●			
Browse surveys	●	●		●	●	●	●
Dead Deer Surveys					●		●
Pellet Counts	●			●	●	●	●
Scat Collection		●		●		●	●
Porcupine Damage Survey					●		
Roadside counts		●	●	●	●		
Caribou Calving Ground Surveys	●						
Summer							
Small Mammal Trapping	●	●	●	●	●	●	●
Fox den site survey				●			
Roadside Counts		●			●		
Scent Post Survey					●		
Bat Collecting				●			
Fall							
Beaver colony survey	●	●	●	●	●	●	●
Beaver Habitat Analysis				●	●	●	●
Muskrat House Count				●			
Raccoon live-trapping					●		
Snowshoe Hare live-trapping				●			●
General							
Exclosure Studies	●			●	●	●	●
Autopsies	●			●	●	●	
Wildlife Observation Program	●			●	●	●	●

Table 7: Moose observations in relation to vegetation types in Gros Morne National Park.

Vegetation Types*	Number of moose Observed	Percent of total
Fv	243	41.4
Fv-T	18	3.1
Fh	12	2.0
Fhv	6	1.0
Fhd	18	3.1
Fhd-FB	2	0.3
Fhd-fr	5	0.8
Fh-FB	4	0.7
Fa	2	0.3
FBu-T	3	0.5
Fm	27	4.6
Fmd	16	2.7
Fmd-Fr	2	0.3
Fr	2	0.3
Fr-Fmd	1	0.2
FB	32	5.4
FB-Fhd	1	0.2
FBu	32	5.4
FB-Sb	3	0.5
Fr-Cs	15	2.6
Subtotal	444	75.4
Sb	13	2.2
Sbd	2	0.3
SbHs	2	0.3
Sb-Fm	2	0.3
Subtotal	19	3.1
Sph	2	0.3
SpF	2	0.3
SpF-Hs	2	0.3
Sph-Hs	2	0.3
Subtotal	8	1.2
He	9	1.5
He-T	17	2.9
He-Fv	4	0.7
He-CS	1	0.2
Subtotal	31	5.3
Cs	10	1.7
Cs-Fv	2	0.3
Subtotal	12	2.0
T-He	15	2.6
T	22	3.7
T-Fv	27	4.6
T-FBu	2	0.3
T-Sb	2	0.3
T-C	1	0.2
T-Cs	4	0.7
Subtotal	73	12.4
Total	587	

Vegetation types defined by Airphoto Analysis Associates, 1975

Table 8: Distribution of deer, moose, and snowshoe hare pellets in the biophysical regions and districts of Cape Breton Highlands National Park.

Region	District	Plots	Pellets Deer	Pellets Moose	Pellets Hare	Pellets per Hectare Deer	Pellets per Hectare Moose	Pellets per Hectare Hare
Acadian	Deciduous Canyon	708	98	13	4563	280	37	13,037
	Deciduous Slope	138	19	-	2163	271	-	30,900
	Atlantic Slope	284	14	10	2138	99	70	15,056
TOTAL ACADIAN (20,000 ha)								
Boreal	Balsam Fir Plateau	380	39	14	9619	205	74	50,626
	Balsam Fir Valley	40	-	-	793	-	-	39,650
	Balsam Fir Ridge	-	-	-	-	-	-	-
	Balsam Fir Taiga	40	0	0	433	0	0	21,650
TOTAL BOREAL (50,000 ha)								
Taiga	High Plateau Mire	-	-	-	-	-	-	-
	High Plateau Barren	40	-	2	90	-	100	4,500
TOTAL TAIGA (20,000 ha)								
TOTAL PARK		1630	170	39	19,799	209	48	24,145

Table 9: Distribution of deer, moose and hare pellets in the land systems of Cape Breton Highlands National Park.

Land System No.	Name	Plots	Deer No.	Deer No./ha	Moose No.	Moose No./ha	Hare No.	Hare No./ha
1	Cheticamp Floodplain	32	1	63	-	-	99	6,188
2	Cheticam Ridge	58	11	379	-	-	446	15,379
3	Cape Rouge Slope	40	6	300	-	-	257	12,850
4	Jerome-Robert Bk. Canyon	40	4	200	-	-	56	2,800
5	Cheticamp R. Canyon	40	5	250	-	-	105	5,250
6	Cheticamp R. Highlands				not sampled			
7	Fishing Cove Slope	40	2	100	-	-	1460	73,000
8	Trout-Corney Bk. Canyon	40	15	750	1	50	520	26,000
9	Jumping Bk. Canyon	40	4	200	-	-	1300	65,000
10	George Bk-Fishing Cove Canyon	40	-	-	-	-	793	39,650
11	Mackenzie R. Canyon	40	1	50	-	-	185	9,250
12	Pleasant Bay Barrens	40	1	50	6	300	2202	110,100
13	Pleasant Bay Slope	38	2	105	-	-	50	2,632
14	MacIntosh Bk-Grande Anse Canyon	40	6	300	3	150	55	2,750
15	MacIntosh-Fishing Cove Highlands	40	6	300	-	-	3241	162,050
16	Jerome Mtn-Corney Bk.Plateau	40	6	300	-	-	1007	50,350
17	Robert Bk. Plateau	40	6	300	1	50	298	14,900
18	Highlands single patterned Mire				not sampled			
19	Cape Breton Plateau Mire	40	-	-	-	-	433	21,650
20	Cape Breton Highlands Plateau				not sampled			
21	Aspy R. Fault	80	26	650	4	100	640	16,000
22	Highlands Patterned Mire Complex				not sampled			
23	Grande Anse Highlands	80	10	250	2	50	830	20,750
24	Aspy R. Flat	39	3	153	-	-	267	13,692
25	Southwest Highlands				not sampled			
26	Clyburn Plateau Barrens				not sampled			
27	Glasgow Bk. Barrens				not sampled			
28	Black Brook Canyon				not sampled			
29	Dundas, Roper Lakes Plateau				not sampled			
30	Clyburn Bk. Canyon	80	7	175	-	-	192	4,800
31	Clyburn Valley	39	2	103	-	-	88	4,513
32	Ingonish Pt.	14	-	-	3	429	47	6,714
33	Ingonish Upland	100	7	140	3	60	1320	26,400
34	Sunday Lake Plateau				not sampled			
35	Clyburn Highlands	40	3	150	2	100	721	36,050
36	Roper-Warren Bk. Canyon	80	11	275	1	25	361	9,025
37	Warren Lake Uplands	40	1	50	3	150	20	1,000
38	Warren Lake Terrace	40	3	150	4	200	254	12,700
39	Mary Ann-Black Bk. Uplands	80	6	150	1	25	534	13,350
40	Mary Ann Bk. Plateau	40	-	-	2	100	90	4,500
41	Halfway Bk. Canyon				not sampled			
42	Broad Cove Lowlands	70	3	86	-	-	569	16,257
43	Neils Harbour Uplands	80	2	50	2	50	734	18,350
44	Aspy-Effies Bk.Canyon	40	10	500	1	50	625	31,250

Table 10: Deer, moose, and hare pellet distibution in the vegetation types of Cape Breton Highlands National Park.

	Vegetation Type	Plots	Pellets			Pellets		
			Deer	Moose	Hare	Deer	Moose	Hare
1	Hemlock	18	-	3	48	-	333	5,333
2	Beech	65	4	-	143	123	-	4,400
3	Sugar Maple	343	55	11	968	321	64	5,644
4	White Birch, Yellow Birch	83	19	1	607	458	24	14,626
5	Balsam Fir-tolerant hardwoods	39	8	-	371	410	-	19,026
6	Spruce, Fir, Pine-intolerant hardwoods	97	5	2	779	103	41	16,062
7	Balsam Fir, Black Spruce	111	3	-	1253	54	-	22,577
8	White Birch, Trembling Aspen, Red Maple	4	-	-	3	-	-	1,500
9	Red Maple	18	1	-	110	111	-	12,222
10	Jack Pine	-	-	-	-	-	-	-
11	White Spruce	99	14	-	650	283	-	13,131
12	Fields	24	3	-	130	250	-	10,833
13	Talus	16	-	-	64	-	-	8,000
14	White Spruce, Balsam Poplar, White Birch	18	2	-	95	222	-	10,556
15	Black Spruce	36	3	1	172	167	56	9,556
16	Sphagnum Mire	34	1	-	147	59	-	8,647
17	Sedge Mire	10	-	-	198	-	-	39,600
18	Balsam Fir	322	41	10	6353	255	62	39,460
19	Balsam Fir, White Birch	60	1	2	1529	33	67	50,967
20	White Birch, Balsam Fir	71	4	6	2130	113	169	60,000
21	White Spruce, White Birch, Pin Cherry	81	4	-	3673	99	-	90,691
22	Dwarf Black Spruce	15	2	1	42	267	133	5,600
23	Barrens	66	-	2	329	-	61	9,970
24	Miscellaneous	-	-	-	-	-	-	-
	TOTAL PARK	1,630	170	39	19,799	207	48	24,145

Table 11: Relative distribution of plots and pellets of deer, moose and hare in the vegetation types of Cape Breton Highlands National Park.

	Vegetation Type	Percent of Total Plots	Percent of Total Pellets		
			Deer	Moose	Hare
1	Hemlock	1.1	-	7.7*	0.2
2	Beech	4.0	2.4	- **	0.7
3	Sugar Maple	21.0	32.4*	28.2	4.9
4	White Birch, Yellow Birch	5.1	11.2*	2.6	3.1
5	Balsam Fir-tolerant hardwoods	2.4	4.7	-	1.9
6	Spruce, Fir, Pine-intolerant hardwoods	6.0	2.9	5.1	3.9
7	Balsam Fir, Black Spruce	6.8	1.8	-	6.3
8	White Birch, Trembling Aspen, Red Maple	0.3	-	-	0.02
9	Red Maple	1.1	0.6	-	0.6
10	Jack Pine	-	-	-	-
11	White Spruce	6.1	8.2	-	3.3
12	Fields	1.5	1.8	-	0.7
13	Talus	1.0	-	-	0.3
14	White Spruce, Balsam Poplar, White Birch	1.1	1.2	-	0.5
15	Black Spruce	2.2	1.8	2.6	0.9
16	Sphagnum Mire	2.1	0.6	-	1.0
17	Sedge Mire	0.6	-	-	1.0
18	Balsam Fir	19.8	24.1	25.6	32.1*
19	Balsam Fir, White Birch	3.7	0.6	5.1	7.7*
20	White Birch, Balsam Fir	4.4	2.4	15.4*	10.8*
21	White Spruce, White Birch, Pin Cherry	5.0	2.4	- **	18.6
22	Dwarf Black Spruce	0.9	1.2	2.6	0.2
23	Barrens	4.1	-**	5.1	1.7
24	Miscellaneous	-	-	-	-

* Significantly more than expected (P 0.05)
** Significantly less than expected (P 0.05)

Table 12: Distribution of pellets in major forest types in Cape Breton Highlands National Park.

Forest Type	Plots	Pellets			Pellets per hectare		
		Deer	Moose	Hare	Deer	Moose	Hare
Softwood [1]	601	63	15	8518	210	50	28,346
Mixed Wood (mainly softwoods)	295	20	4	6447	136	27	43,708
Mixed Wood (mainly hardwoods) [3]	71	4	6	2130	113	169	60,000
Total Mixed Wood	366	24	10	8577	131	55	46,867
Hardwood [4]	513	79	12	1831	208	47	7,138
Open [5]	150	4	2	868	53	27	11,573
TOTAL	1,630	170	39	19,799	209	48	24,293

1 Vegetation Types 1, 7, 10, 11, 15, 18, 22
2 Vegetation Types 5, 6, 14, 19, 21
3 Vegetation Types 20
4 Vegetation Types 2, 3, 4, 8, 9
5 Vegetation Types 12, 13, 16, 17, 23

Table 13: Distribution of deer, moose and hare pellets in height, density, and condition classes of the forests of Cape Breton Highlands National Park.

Class	Plots	Pellets			Pellets per hectare		
		Deer	Moose	Hare	Deer	Moose	Hare
HEIGHT CLASS							
1 1-5 ft.	16	2	1	112	250	125	14,000
2 6-15 ft.	194	9	8	6139	93	82	63,289
3 16-25 ft.	348	43	7	4155	247	40	23,879
4 26-35 ft.	431	51	7	5972	237	32	27,712
5 36-45 ft.	214	17	3	552	159	28	5,159
6 46-55 ft.	129	12	8	367	186	124	5,690
7 56-65 ft.	140	32	3	556	457	43	7,943
8 66 ft			- not sampled -				
9 all heights	18	-	-	1073	-	-	119,222
DENSITY CLASS							
A 0-40%	31	2	3	252	129	194	16,258
B 41-60%	222	11	2	3766	99	18	33,928
C 61-100%	1034	40	21	10529	271	41	20,366
D patchy	203	13	8	4601	128	79	45,330
CONDITION CLASS							
1 Young regeneration	9	-	2	229	-	444	50,889
2 Young 16-25 yrs.	52	4	-	2499	154	-	96,115
3 Young 26-40 yrs.	115	12	-	606	209	-	10,539
3a Young retarded	4	1	-	92	500	-	46,000
4 Mature 41-55yrs.	512	62	16	3361	242	63	13,129
4a Mature retarded	34	-	-	565	-	-	33,235
5 Mature 56-70yrs.	326	23	5	1278	141	31	7,840
6 Stunted	287	46	12	7246	321	84	50,495
7 Dwarfed	18	3	1	54	333	111	6,000
8 Overmature	133	15	1	3545	226	15	53,308

Table 14: Distribution of deer, moose and hare pellets in forest canopy types of Cape Breton Highlands National Park.

Canopy Description	Plots	Pellets Deer	Pellets Moose	Pellets Hare	Pellets per hectare Deer	Pellets per hectare Moose	Pellets per hectare Hare
open	149	4	2	868	54	27	11,651
1C1	1	-	-	70	-	-	140,000
1C7	15	2	1	42	267	133	5,600
2B6	33	-	-	1007	-	-	61,030
2C1	8	-	2	159	-	500	39,750
2C2	52	4	-	2499	154	-	96,115
2C6	45	2	-	611	89	-	27,156
2D6	56	3	6	1863	107	214	66,536
3B4	78	4	1	498	103	27	12,769
3B4a	3	-	-	25	-	-	16,667
3B5	6	1	-	97	333	-	32,333
3B8	13	2	-	324	308	-	49,846
3C3	70	10	-	558	286	-	15,943
3C3a	4	1	-	92	500	-	46,000
3C4	55	12	5	445	436	182	16,182
3C6	32	4	1	446	250	63	27,875
3C7	3	1	-	12	667	-	8,000
3C8	10	3	-	135	600	-	27,000
3D4	9	-	-	52	-	-	11,556
3D4a	23	-	-	320	-	-	27,826
3D6	32	2	-	288	125	-	18,000
3D8	10	3	-	863	600	-	172,600
4A5	3	1	-	31	667	-	20,667
4A8	6	1	-	171	333	-	57,000
4B4	10	3	1	234	600	200	46,800
4B6	22	-	-	483	-	-	43,909
4B8	35	-	-	788	-	-	45,029
4C3	20	2	-	14	200	-	1,400
4C4	200	27	3	1582	270	30	15,820
4C4a	8	-	-	220	-	-	55,000
4C5	19	8	-	259	842	-	27,263
4C6	19	2	-	517	211	-	54,421
4C8	32	2	-	595	125	63	37,188
4D6	30	1	2	409	67	133	27,267
4D8	27	4	-	669	296	-	49,556
5B4	9	1	-	83	222	-	18,444
5C3	25	-	-	34	-	-	2,720
5C4	96	10	3	305	208	63	6,354
5C5	84	6	-	130	143	-	3,095
6A5	14	-	3	47	-	429	6,714
6B5	4	-	-	1	-	-	500
6C4	30	5	3	21	333	200	1,400
6C5	65	7	2	161	215	62	4,954
6D4	16	-	-	137	-	-	17,125
7A5	8	-	-	3	-	-	750
7B4	9	-	-	4	-	-	889
7C5	123	32	3	549	520	49	8,927
9C6	18	-	-	1073	-	-	119,222

Table 15: Distribution of pellets in relation to available browse in Cape Breton Highlands National Park.

Available Browse*	Plots	Pellets Deer	Pellets Moose	Pellets Hare	Pellets per hectare Deer	Pellets per hectare Moose	Pellets per hectare Hare
Abundant	320	57	10	8046	356	63	50,288
Moderate	283	29	10	3336	207	71	23,829
Little	678	59	11	6148	174	32	18,082
None	349	25	8	2269	147	47	13,347

* Deciduous shrubs

tion of canopy height and condition classes for deer, moose, and hare are 7C3a, 1A1, and 9D2, respectively (ie 56-55 ft., 61-100% density, young retarded stands for deer; 1-5 ft., 0-40%, young regeneration for moose; and all heights (variable), patchy density, young (12-65 yrs.) stands for hare). However, none of those combinations existed on the plots sampled. Most deer, moose, and hare pellets occurred in forest canopy combinations 4C5, 2C1, and 3D8, respectively (Table 14). Preferred canopy height, density, and condition characteristics may also vary when correlated with canopy composition or some of the other abiotic characteristics.

Under most circumstances and for most mammals, combinations of several habitat characteristics should be used to correlate species abundance and distribution. In general, basic vegetation type or plant community designations have been the most useful land characteristics for mapping mammal distribution and abundance in the Atlantic National Parks particularly when correlated with shrubs and ground vegetation (Table 16).

SUMMARY

Wildlife studies to date have indicated that vegetation type and, in particular, forest canopy composition are the most significant habitat characteristics for most mammals. Few mammals are specific to one vegetation type, and for most species a variety of vegetation types are used, often in specific combinations. Under-canopy vegetation, particularly the composition of shrubs and ground vegetation, is also important to many mammals. Snow accumulation information seems to be the most important abiotic habitat characteristic for mammals. Wildlife information gathered by BLI field crews directly is inadequate owing to their sampling technique and sample size. Because of the limited amount of understory vegetation information in the land type classification, land systems have proven to be the most useful land units for most wildlife inventory sampling in the Atlantic Region National Parks.

REFERENCES

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EER Ltd., 1978. Cape Breton Highlands National Park, Ecological Land classification. Manuscript Report to Parks Canada. 5 volumes maps.

WILDLIFE DISTRIBUTION IN THE HAYES RIVER AREA, MANITOBA

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ABSTRACT

Wildlife studies were undertaken in the Hayes River map area in an attempt to correlate wildlife populations with biophysical units. Information was gathered on a variety of species to illustrate the complexity of species-habitat relationships. Because of time limitations selected species of economic importance (caribou, moose, and waterfowl) were emphasized. Prime caribou and moose habitat appeared to distinguishable at the ecodistrict level however moose were also correlated with the riparian habitats of the Hayes River and its major tributaries.

RÉSUMÉ

On a entrepris des études fauniques dans la région cartographique de la riviere Hayes afin de tâcher d'établir les relations qui existent entre les populations fauniques et les zones biophysiques. On a accumulé des renseignements sur une variété d'especes en vue de montrer la complexité des rapports especes/habitat. Etant donné le manque de temps, on a mis l'accent sur certaines especes qui représentent une importance économique (caribou, orignal, oiseaux aquatiques). L'étude a révélé qu'il semble possible de distinguer l'habitat préféré par le caribou et l'orignal a l'échelle de l'ecodistrict. On a cependant pu faire un certain rapprochment entre la présence d'orignaux et les habitats situés le long de la riviere Hayes et de ses tributaires.

INTRODUCTION

Wildlife studies, in the Hayes River area, were carried out as part of the Northern resource Information Program (NRIP) initiated in July 1974 and funded through the Manitoba Northlands Agreement. The objectives of this program have been discussed in the guide that accompanies the biophysical map for the Hayes River map sheet. Methods, definitions and concepts that relate to biophysical land classification are also presented in the guide (Mills et al, 1976).

OBJECTIVES

My main objective was to show how the distribution of wildlife populations related to biophysical units. I gathered information on a variety of species to illustrate the complexity and variability of species-habitat relationships and to provide a broad inventory of northern wildlife. Because of time limitations, I focused on selected species, including those considered important for economic reasons (moose, caribou, waterfowl) and those small mammals and small terrestrial birds thought best to represent particular land-vegetation associations. Data on other wildlife, such as fur-bearers, raptors, shorebirds, wading birds and grouse, were taken largely from the literature and from "incidental" records obtained in the field.

Because the pilot study began late in the field season and on short notice, I was unable to carry out small mammal and bird investigations. The moose, caribou and waterfowl studies were completed as planned.

STUDY AREA

The Hayes river map area, located in northeastern Manitoba between the 56th and 57th parallels and the 92nd and 94th meridians, is approximately 13780 km^2 (Figure 1). Most of the map sheet lies in the Hudson Bay Lowlands Weir, 1960) where elevations above sea level range from about 120 m in the extreme southwest to 150 m in the southeast and 15 m in the northwest corner. Topography is mostly level to very gently undulating, and the general fall of the land is towards the northeast. The overall flatness of the terrain is interrupted by a few beach ridges and drumlins which provide low to moderate relief.

1 Abstracted from: Wildlife Distribution in the Hayes River Map Area (54C) by R.K. Schmidt, 1977. A report to accompany Biophysical land Classification Hayes River 54C Manitoba. G.F. Mills, H. Veldhuis, D.B. Forrester, and R.K, Schmidt. Northern Resource Information Program, 1976. - Ed.

The Hudson Bay Lowlands are underlain by limestones and dolostones of Ordovician and Silurian Ages; in the southwestern corner, underlying bedrock is Precambrian granite and gneiss. Except for a few exposures in deep river channels, bedrock is masked by thick unconsolidated deposits of various origins.

Till of Illinoian Age or older overlie Paleozoic bedrock; fluvial, lacustrine and organic materials were deposited on these tills following ice retreat. During the Wisconsin Ice Age, at least three more tills were laid down on top of the interglacial beds. The Tyrrell Sea, which inundated most of the area about 7,600 years ago, laid down beaches and marine sediments of varying thicknesses on top of Wisconsin tills. In recent post-glacial times, lands covered by sea water have risen gradually by means of isostatic rebound so that many former beaches are now 120 to 150 m above sea level. Organic materials which blanket most of the older marine sediments, are the dominant surface features in the area today.

Three major rivers--the Nelson, the Hayes and the Gods--flow northeast and empty into Hudson Bay near York Factory. The Nelson River and its tributaries drain the northwestern part of the region, while the remaining area falls within the Hayes-Gods River watershed. Much of the land surface is poorly drained. Small creeks and streams form an intricate network across the map area. These exhibit marked meander patterns, have slow rates of flow and are blocked in some places by beach ridges. There are also two clusters of lakes, one in the southeast along the Gods River and one in the west-central part of the map in the vicinity of Angling River (Figure 1). Most are small by northern Manitoba standards (approximately 5 to 1,000 ha), all are shallow (less than 5 m) and the majority have peaty shorelines with muck bottoms and sparse aquatic vegetation.

The climate grades from high boreal in the southwest to low subarctic type in the northeast. The frost-free season averages about 85 days in the south and 70 days in the north. In January the mean temperature over the entire area ranges from -26° to -31°C while July means vary from 11° to 16°C. Average annual precipitation varies from 450 mm in the southeast to about 400 mm in the extreme northeast, most of it (about 70%) falling between April and September.

METHODS

Ungulate Surveys

Aerial surveys of moose (Alces alces) and woodland caribou (Rangifer tarandus caribou) were conducted in the Kettle Rapids and Hayes River map areas from March 10 to 22, 1975. The objectives were to estimate winter population densities and to determine the distribution of both species on the basis of animal and track sightings. The latter were collected to establish habitat preferences of the two species.

A randomized strip census method, modified from Caughley (1975), was developed for the surveys; however, this proved unsuitable owing to the unacceptably low numbers of moose and caribou observed on individual transects. Therefore, a simplified strip census was used. Twenty-four east-west transects were plotted on a 1:250,000 scale base map and then transferred to vertical aerial photographs (approximately 1:60,000 scale). Lines running parallel to the Universal Transverse Mercator Grid were marked at alternating 4,000 and 5,000 m intervals from a randomly selected starting point.

The surveys were conducted from a height of 240 m and 125 km/hr. All animal counts for population estimates were made by one observer in the back seat viewing from one side of the aircraft. The observer on the opposite side in the front seat plotted animal and track sightings on aerial photographs and assisted the pilot with navigation. Both observers restricted their field of view to a 0.3 km strip of ground marked by 1.25 cm dowels attached to the wing struts. Placement of the dowels was determined by flying repeatedly over the Thompson. Manitoba airstrip which was lined with beacons at 180 m intervals.

I had also hoped to measure snow depth, density and hardness using techniques described by Pruitt (1960) on at least 20 sites, some in areas frequented by moose, caribou and others in places that appeared uninhabited. Unfortunately, because of poor snow conditions for landing, I was able to sample only two sites, both in the Kettle Rapids map sheet. I will refer to these data to give a general impression of snow conditions in the region at the time of the surveys, with the understanding that broad extrapolations based on a sample size of two are highly suspect.

Following the surveys, I examined air photos stereoscopically to identify the biophysical units, principally 'Land Types' where animals or their tracks were seen. I then used soils, landform and vegetation data collected by other

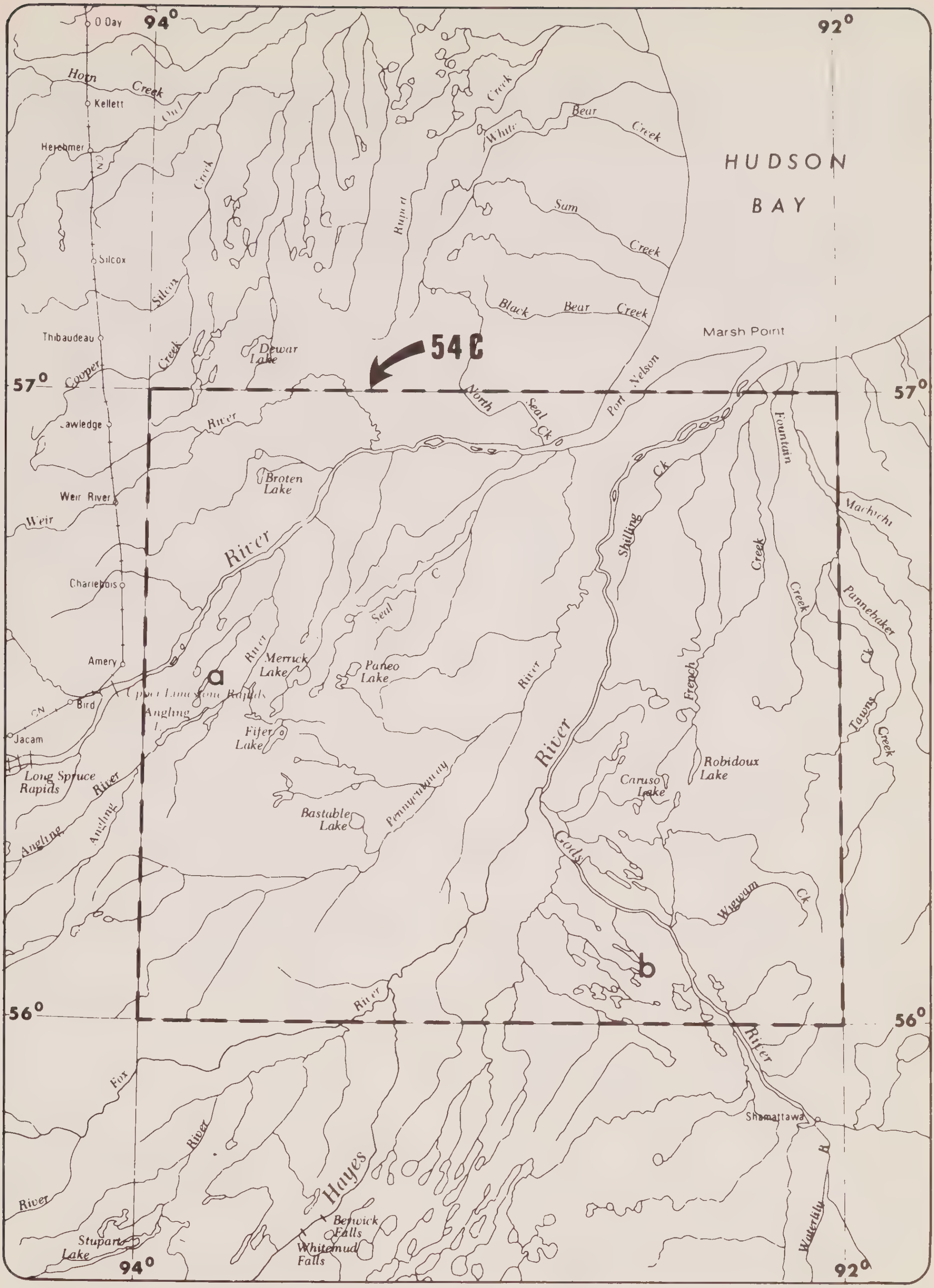

Figure 1: The Hayes River map area, showing the Angling River (a) and Gods River (b) lake clusters.

members of the team to derive habitat descriptions for the different units. 'Land Systems' and 'Districts' were evaluated by comparing the frequency of animal-track sightings within different habitat associations.

No systematic surveys for moose or caribou were conducted in the summer of 1974; however, animals observed during other investigations were recorded on 1:250,000 scale base maps or on air photos by all team members. D. Casell, A. Didiuk and A. Beck (Manitoba Department of Mines, Resources and Environmental Management) provided me with additional records obtained during waterfowl surveys made that same summer.

Waterfowl surveys

Waterfowl counts were made on 48 water bodies in the Angling River lake cluster and on 30 lakes in the God's River cluster (Figure 1). Sample lakes were selected in the following manner: each water body within the two clusters (as shown on a 1:250,000 scale map) was assigned a number and divided into two broad categories: large lakes and medium-to-small lakes. The division between large and medium-sized lakes was made simply by inspecting the map and marking those that appeared to have a significantly greater surface area than the others. Admittedly, this is an arbitrary method of stratification; however, I did not have time to compute actual water areas from air photos prior to the field season. All large lakes were included for survey (eight in the Angling River cluster and seven in the Gods River group). A random sample of 40 lakes (13%) was selected from the remaining 312 at Angling River, while 32 lakes (11%) were chosen from 300 in the Gods River cluster.

I conducted the surveys from a Bell 206B helicopter from August 20 to 28, 1974. The periphery of each lake was flown on the inshore side at approximately 30 m altitude and at 100 km/hr. Additional flights were made over the middle of large lakes to locate waterfowl that could not be spotted from shore. Numbers and species were recorded on field forms. I also made two waterfowl counts along the Hayes River from Ten Shilling Creek to its junction with God's River and flew a survey of the Nelson River from its mouth to the edge of the map area.

Information on physical characteristics of water bodies was gathered according to the methods of Nelson and Falkner (1971). Shoreline and backshore features (topography, materials and vegetation) and bottom characteristics were noted for all survey lakes.

Turbidity, depth and temperature were measured for 12 lakes in the Angling River cluster and for 11 lakes in the God's River cluster; one-litre water samples were also taken and analyzed by H. Ayles at the Freshwater Institute, Winnipeg. I measured surface areas and circumferences of all sample lakes using an electronic planimeter. Shoreline development was computed using the formula L/(2A) where L is the length of the shoreline and A is the surface area.

RESULTS AND DISCUSSION

Only 20 caribou in three groups were observed on the 11 survey transects covering approximately 1360 km. This is a frequency of one caribou per 46.9 km as all observed animals occurred outside the 0.3 km survey strip, we could not compute caribou densities; it would appear, however, that groups (consisting of 7, 10 and 12 animals) were located in the French River Land District some three miles southwest of Gods River. We also recorded 125 separate track sightings, most of which were located in the southern half of the map sheet. I later learned from pilots in Gillam, Manitoba that large numbers of caribou had moved into areas lying south of the Hayes River map sheet with the largest concentrations occurring in the vicinity of Fox River.

Examination of records plotted on aerial photographs combined with notes on habitat made during the surveys showed caribou occurred on 10 different habitat types or landform units (Table 1). Upland sites such as beaches, drumlins and peat plateaus were used consistently for feeding and occasionally for bedding. Feeding craters were sometimes observed in string fens, along willow-lined

Table 1: Habitat use by moose and caribou as indicated by track patterns in the Hayes River map area, March 1975

	Landform type								
Species	Bt-Fp	Bv	Fp*	Fh	Md	Ap	Wr	Wa	Wp
Caribou (n 125)	55	12	7	6	6	13	16	2	8
Moose (n 45)	5	1	17	0	0	16	3	1	2

*Refers only to water-track fens

Key:
- Ap Alluvial plain
- Bt Peat plateau
- Bv Bog veneer
- Fh Horizontal fen
- Md Drumlinized moraine
- Wa Marine apron
- Wp Marine plain
- Wr Marine ridge

rivers and creeks and in water-track fens; however, these lowland habitats appeared to be most important for loafing, travel and bedding. Tracks were often seen running to and from lakes but sign on the lakes was nearly always obscured by wind-blown snow. Of the three bands of caribou observed, one was loafing on a small lake; the other two were loafing in narrow patterned fens connecting peat plateaus and lakes.

Areas used most by caribou in mid-March were in the French River and Wigwam Creek Land Districts where 52% of all sightings occurred. These districts also provided the best mixture of landforms, water, vegetation communities and high relief features available in the map area. There was also evidence of heavy caribou use in the Hayes River Land District south and east of the Hayes River. Ron Larch (personal communication) noted on previous aerial surveys that the triangle of land bounded by the Hayes and God's rivers was an important winter concentration area. Landform associations in this part of the Hayes River District are practically identical to those in the French River District. Approximately 30% of track sightings were recorded in the southwest portion of the map area in both the Fox River and Angling River Land Districts. Peat plateaus and patterned fens cover almost all of this area although there are some isolated beaches and bog veneers. Pennycutaway River and its tributaries provide the only alluvial habitats. Lakes are few and far between.

Very little caribou sign (track sightings) was observed in the central portion of the Angling River District which contains a large cluster of lakes bordered on the east by a prominent beach ridge. Landforms within the lake cluster area are dominated by peat plateaus, bog veneers and patterned fens. There was also little evidence of caribou use in the central part of the Hayes River district where peat plateaus and fens cover over 90% of the area.

We obtained no positive records of caribou use in the northern third of the map area (three transects). A large portion of the northeast corner (York Factory and Hayes River Land Districts) is covered by extensive fens interspersed with widely spaced peat plateau "islands". There are only a few exposed beaches and alluvial-marine deposits bordering the Nelson and Hayes rivers, but the overall pattern of landforms appears less suitable for caribou than those lying further south. No caribou sign was observed north of the Nelson River.

Burns of various ages were scattered throughout the map area but were small in area compared to burns in bedrock terrain to the south. These areas were conspicuous from the air owing to the absence of mature trees and the presence of open stands of young black spruce and burned-out snags. Caribou sign was never observed on recent burns, indicating such habitats are deliberately avoided. In many other places, peat plateaus and bog veneers supported open to very-open stands of mature black spruce; however, these were not considered as burns even though such conditions may have resulted from very old fires. Unfortunately, I did not differentiate bog areas used by caribou according to tree cover, but it appeared that open stands (10-20% cover) received heavier use than more closed stands (greater than 50% cover).

Few caribou were seen in the Hayes River map area during summer studies, 1974. From August 18 to 28, we observed only six animals including two females with single calves; all were in fens near or adjacent to water bodies. Caribou also used upland sites such as beach ridges, peat plateaus, bog veneers and alluvium as indicated by the presence of fresh tracks, well-worn game trails and droppings.

Results of the survey showed that woodland caribou in the Hayes River map area use, or at least wandered across, virtually all landform or "habitat" types present. Examination of track patterns suggests that well-drained mineral landforms are preferred over the organic landforms that dominate the area. The figures in Table 1 show that 36% of track sightings were on mineral sites that cover no more than 10% of the total area. It would appear then that caribou seek out these well-drained sites in winter.

The relationship of caribou distribution to the pattern of land systems as shown on the Biophysical Map is not clear. In the first place, my data on caribou are not detailed enough to permit rational differentiation of individual land systems according to their relative value to caribou. In the second place, the criteria used to identify and delineate land systems are probably finer than those needed to identify different quality habitats for caribou. Even superficial study of the Biophysical Map will reveal that many adjacent land systems are more similar than they are different and that in most cases the differences reflect slightly different proportions of the same landform elements.

That caribou tend to be nomadic and use a wide variety of habitats in winter has been documented in other studies. In February and March of 1974, R. Robertson and D. Cross

members of the team to derive habitat descriptions for the different units. 'Land Systems' and 'Districts' were evaluated by comparing the frequency of animal-track sightings within different habitat associations.

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RESULTS AND DISCUSSION

Only 20 caribou in three groups were observed on the 11 survey transects covering approximately 1360 km. This is a frequency of one caribou per 46.9 km as all observed animals occurred outside the 0.3 km survey strip, we could not compute caribou densities; it would appear, however, that groups (consisting of 7, 10 and 12 animals) were located in the French River Land District some three miles southwest of Gods River. We also recorded 125 separate track sightings, most of which were located in the southern half of the map sheet. I later learned from pilots in Gillam, Manitoba that large numbers of caribou had moved into areas lying south of the Hayes River map sheet with the largest concentrations occurring in the vicinity of Fox River.

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Key:			
Ap	Alluvial plain	Md	Drumlinized moraine
Bt	Peat plateau	Wa	Marine apron
Bv	Bog veneer	Wp	Marine plain
Fh	Horizontal fen	Wr	Marine ridge

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Very little caribou sign (track sightings) was observed in the central portion of the Angling River District which contains a large cluster of lakes bordered on the east by a prominent beach ridge. Landforms within the lake cluster area are dominated by peat plateaus, bog veneers and patterned fens. There was also little evidence of caribou use in the central part of the Hayes River district where peat plateaus and fens cover over 90% of the area.

We obtained no positive records of caribou use in the northern third of the map area (three transects). A large portion of the northeast corner (York Factory and Hayes River Land Districts) is covered by extensive fens interspersed with widely spaced peat plateau "islands". There are only a few exposed beaches and alluvial-marine deposits bordering the Nelson and Hayes rivers, but the overall pattern of landforms appears less suitable for caribou than those lying further south. No caribou sign was observed north of the Nelson River.

Burns of various ages were scattered throughout the map area but were small in area compared to burns in bedrock terrain to the south. These areas were conspicuous from the air owing to the absence of mature trees and the presence of open stands of young black spruce and burned-out snags. Caribou sign was never observed on recent burns, indicating such habitats are deliberately avoided. In many other places, peat plateaus and bog veneers supported open to very-open stands of mature black spruce; however, these were not considered as burns even though such conditions may have resulted from very old fires. Unfortunately, I did not differentiate bog areas used by caribou according to tree cover, but it appeared that open stands (10-20% cover) received heavier use than more closed stands (greater than 50% cover).

Few caribou were seen in the Hayes River map area during summer studies, 1974. From August 18 to 28, we observed only six animals including two females with single calves; all were in fens near or adjacent to water bodies. Caribou also used upland sites such as beach ridges, peat plateaus, bog veneers and alluvium as indicated by the presence of fresh tracks, well-worn game trails and droppings.

Results of the survey showed that woodland caribou in the Hayes River map area use, or at least wandered across, virtually all landform or "habitat" types present. Examination of track patterns suggests that well-drained mineral landforms are preferred over the organic landforms that dominate the area. The figures in Table 1 show that 36% of track sightings were on mineral sites that cover no more than 10% of the total area. It would appear then that caribou seek out these well-drained sites in winter.

The relationship of caribou distribution to the pattern of land systems as shown on the Biophysical Map is not clear. In the first place, my data on caribou are not detailed enough to permit rational differentiation of individual land systems according to their relative value to caribou. In the second place, the criteria used to identify and delineate land systems are probably finer than those needed to identify different quality habitats for caribou. Even superficial study of the Biophysical Map will reveal that many adjacent land systems are more similar than they are different and that in most cases the differences reflect slightly different proportions of the same landform elements.

That caribou tend to be nomadic and use a wide variety of habitats in winter has been documented in other studies. In February and March of 1974, R. Robertson and D. Cross

(personal communication) flew eight east-west transects across the southern two-thirds of the Hayes River map area and made several passes over the northeastern corner. They counted a total of 248 caribou in 10 groups during several separate surveys from March 7 to 30. Except for one band of seven animals in the Wigwam Creek District, all sightings were made in the central portion of the map area (Hayes River District). On surveys conducted between February 19 and 23, they recorded 47 caribou in nine groups; only seven of these were in the southeastern part of the map area. Most of the caribou sign observed by Robertson and Cross during all surveys was in central or south-central parts of the map area, with tracks being especially abundant in the Angling River lake cluster. Very few tracks were noted in the eastern area. Neither caribou nor caribou sign were observed in the northeastern corner of the map sheet.

Comparison of survey data from both years shows that caribou were located mainly in the southeastern portion of the map area in 1975; whereas in 1974, use was heaviest in central area. In addition, many more animals were recorded in 1974 than in 1975; however, this discrepancy probably does not indicate a major reduction in caribou numbers--pilots from Gillam, Manitoba reported that (in 1975) the largest concentrations of caribou were located in the vicinity of Fox River, immediately south of the Hayes River map area. These results clearly indicate that caribou wintering in this area are not dependent on particular sites year after year but tend to wander over extensive areas having similar habitat characteristics.

Our failure to find caribou sign north of the Nelson River cannot be explained at this time except to say that they either winter here in very small numbers or not at all. Lack of suitable habitat does not appear to be a serious limiting factor, at least no more so than in the southwest where caribou sign was moderately abundant. Landforms above the Nelson are, as everywhere else, dominated by peat plateaus and patterned fens with bog veneers more common than in other land districts. There are several pockets of glacio-fluvial material and alluvium occurs along the Weir and Roblin rivers. If one assumes that the centre of distribution for this population is to the south as the data indicate, and that bands of caribou do not enter the map area from the northwest, then the high, steep banks of the Nelson (see biophysical map) may discourage movement into the northwest corner.

Habitats found in the Hayes River map area occur in most other caribou wintering ranges. The best areas lie in the northern boreal forest and along the forest-tundra ecotone. This is a region of generally low relief with numerous bogs and fens (often combined under the term muskeg), till ridges, old beaches, eskers, rock outcrops, drumlins, and lakes or potholes (Kelsall, 1968; Pruitt, 1959; Johnson and Rowe, 1975). Lakes and openings are used mainly for escape and travel, whereas better drained spruce-lichen and jack pine-lichen communities proved food and shelter (Kelsall, 1968; Pruitt, 1960).

In a study of woodland caribou winter distribution on the Hudson Bay Lowlands of northwestern Ontario, Brokx (1965) showed that raised bogs interspersed with sedge fens were preferred winter habitats. His Spruce Island and Bog Island muskegs, which appear to be similar to many peat plateau-patterned fen associations described in this study, were among the most important Lowland habitats. Caribou densities in these areas ranged from 13.5 km^2 to 31.9 km^2 per caribou where fire was not a factor. Brokx (1965) noted that ground lichens along with Labrador tea are abundant on raised bogs, while surrounding fens contain mostly sedges, rushes and forbs. Northernmost organic habitats in and adjacent to the tundra zone received little use (69.4 km^2 to 114.9 km^2 per caribou) probably because of unfavourable snow or climatic conditions--factors that may explain the absence of caribou in and adjacent to the High Subarctic Land Region.

Brokx (1965) states that upland areas such as raised bogs and beaches are used primarily for feeding; fens, which are valuable feeding areas in summer, are evidently not an important factor in determining winter distribution but may provide suitable snow conditions for travel. He also points out that caribou tend to feed along the edges of bogs and that interior sites may be inaccessible owing to unfavourable snow conditions. This is not in complete agreement with our findings. Although we did observe that caribou often kept to plateau edges, they just as often traversed extensive plateau fields, cutting across narrow fens rather than moving along them.

The distribution of lichens, the pattern and frequency of fires and quality of snow cover have long been considered important in defining caribou feed on lichens during winter and summer is undisputed. Ahti (in Brokx, 1965) reported that the "Subarctic Lichen Belt", estimated at 176,800 km^2, could support 50,000 caribou and that each 3.9 km^2 of lichen muskeg or lichen woodland would be capable of carrying two caribou over winter.

Pruitt (in Kelsall, 1960) states that better lichen areas in young jack pine stands (2.5 to 3 m tall) provided enough lichens to feed approximately 12,000 caribou for one day or 78 caribou for 150 days, assuming each animal eats 10 pounds of lichens per day. Lichen growth on dry south-facing slopes with 12 m jack pine, could support 439 caribou for one day or three per winter. These figures correspond to densities of eight acres per animal on the best sites and 40 ha per caribou on the worst.

There is some disagreement about which species of lichens are most important to caribou. Many authors consider the ground lichens Cladonia alpestris, C. mitis and C. rangiferian among the most valuable species (Simkin, 1965; Ahti, 1959; Husitch, 1951). Others have suggested that caribou are less restricted in their preference of particular species. Bergerud (1972) listed more than 30 species of lichens found in the rumina of Newfoundland caribou, including both arboreal and terrestrial forms. Crigan (1957) and Edwards and Ritcey (1960) indicated that tree lichens such as those of the genus Alectoria are just as important as the ground forms.

Even though one gets the impression that caribou are almost exclusively lichen grazers in winter, there is considerable evidence to suggest they are feeding generalists. Brokx (1965) and Bergerud (1972) point out that lichens may be more of a staple than a preferred food. The abundance of vascular plants in the diet, as shown in Table 2, is evidently dictated by the accessibility and condition of the species in question. Sedges when available, are readily consumed in winter (Brokx, 1965; Kelsall, 1967) and may make up the bulk of their diet in Alaska during some winters, even when rich lichen ranges are present. Plants such as horsetails, Labrador tea, Vaccinium spp., bunchberry, Kalmia spp., leatherleaf, rushes shrubby cinquefoil and twinflower, which retain green growth in winter and can be reached through the snow, provide relatively high protein forage in an otherwise protein-poor diet dominated by lichens (see Brokx, 1965; Loughrey, 1947; Edwards and Ritcey, 1960; Kelsall, 1968). In the Peace-Athabaska River area, Kelsall (1970) witnessed caribou digging out and devouring the contents of muskrat feeding lodges which contained mostly sedges.

Although caribou are mainly grazers, preferring lichens, sedges and low evergreen shrubs, they may also feed on the terminal shoots of taller shrubs such as willow, alder and birch. In Ontario, Crigan (1957) reported that caribou fed to a limited extent on mountain maple (Acer spicatem), mountain ash (Sorbus americana), red-osier dogwood (Cornus stolonifera), willow, and highbush cranberry (Viburnim trilobum), among others.

In spring and summer, caribou tend to prefer low marshy areas to lichen-rich uplands (Brokx, 1965; Loughrey, 1957). Such sites (ie fens and drainage ways) sustain abundant sedge and forb vegetation mixed with low shrubs that, together, provide high protein forage (Table 2). Burns may also provide forb-grass-shrub regeneration that serves as summer food (Brokx, 1965). Well-drained sites, particularly beaches or drumlins, that become free of snow in early spring are favoured as calving areas (Brokx, 1965; Loughrey, 1957; Skoog, 1956).

Available evidence suggests, then, that caribou are by no means dependent solely upon lichens for survival even in mid-winter. Bergerud (1972) sums up the situation as well as anyone in saying, ". . . the heavy use of lichens does not necessarily imply that lichens are required in the diet if vascular plants are readily available . . . (caribou) are adapted to eat many kinds of foods including lichens, which most other ungulates avoid. This adaptation is one of many that permits the distribution of caribou in northern communities dominated by lichens".

Table 2 lists known caribou foods that were recorded in the Hayes River map area. The species list was compiled from the literature; relative abundance ratings were derived from cover abundance and frequency values as determined from field investigations, where:

Rare - species present on less than 1/3 of sites; cover small to very small;

Sparse - species present on at least 1/3 of sites; generally cover 1/20 of area or less;

Plentiful - species present on at least 1/2 of sites; generally covers 1/4 to 1/2 of area;

Abundant - species present on at least 3/4 of sites; generally covers 1/2 to 3/4 of area.

These definitions are subjective and were applied rather loosely. For example, a species with cover abundance values ranging from to 1 (ie covering less than 1/20 of the area) might still be considered plentiful if it occurs on more than 2/3 of the sites. In general, then, frequency was considered more important than coverage in determining relative abundance ratings.

Table 2: Relative abundance of caribou forage on five dominant land forms of the Hayes River map area.

Species	Relative abundance by landform type				
	Bt	Bv	Fc	Fp	Wr
Alnus crispa*					
Andromeda glaucophylla		R		S	
Arctostaphylos rubra	R	R			
A. uva-ursi	R			S	
Aster spp.					
Betual glandulosa*	R	R		P	R
B. papyrifera		R		R	
Chamaedaphne calyculata		P	A	R	R
Cornus canadensis					S
Drosera spp.			R	R	
Empetrum nigrum	S				R
Epilobium spp.*					R
Equisetum arvense*	S	S	R	S	R
Juniperus communis					R
Kalmia polifolia		R	S		
Larix larician	R		R	P	
Ledum Decumbens*	S				
L. groenlandicum*	A	A		S	P
Linnaea borealis					R
Maianthemum candense				R	
Menyanthes trifoliata	S		S	P	
Oxycoccus microcarpus	S	S	S	S	R
Picea mariana	A	A		R	P
Populus tremuloides					R
Potentialla tridentata					R
Rosa acicularis					S
Rubus chamaemorus*	P	S	R	R	S
Rubus spp.	R				
Salix spp.*	R	R		R	
Vaccinium uliginosum*	R	S		R	S
V. vitis-idaea*	S	S			S
Carex spp.*		R	A	A	S
Eriophorum spp.*			S	S	
Grasses					S
Cladonia alpestris*	A	P			P
C. mitis*	P	P			A
C. rangiferina*	A	S			S
Peltigera spp.		S			
Other Lichens	S	S			S
Fungi*	R				S
Feathermosses	S	S			S
Sphagnum spp.	P	P	A	P	R
Other Mosses	R	S		P	R

* important food species

R - rare P - plentiful
S - sparse A - abundant

The best caribou wintering areas are found in climax stands in boreal and forest-tundra transition regions. Fire, which destroys thousands of square miles of this climax forest each year, has long been considered detrimental to caribou and is thought by some to be a major factor limiting their abundance and distribution in North America. Brokx (1965) found that in northern Ontario, burns were little used by woodland caribou and acted as barriers to animal movements. Scotter (1967), in stating that lichens make up 60% of the winter forage of barren-ground caribou, added that the "average standing crop of high-value lichens varied from one pound per acre in the one to ten-year-old class (burns) to an average of 560 pounds per acre in the class exceeding 120 years". He also reported that caribou pellet group counts in different-age burns ranged from 18 groups in the one-to-ten-year class to 722 in the 120 class and that recovery of lichen stands to their original abundance usually takes about 70 years following fire (Scotter, 1963). However, the rich forb-shrub growth that succeeds fire may provide valuable summer forage for caribou (Brokx, 1965).

Both Pruitt (1959) and Scotter (1967) have noted that, "Open lichen-woodland on drumlinized terrain . . . appears to be less susceptible to burning than western closed forests on bedrock controlled drift . . .". A similar conclusion was drawn in this study through comparison of fire patterns in the organic-morainal terrain of the Hayes river map area with those visible bedrock landforms farther south.

The proposition that caribou are dependant on "climax forest" for survival is by no means indisputable. Johnson and Rowe (1975) point out that "fires recur in boreal vegetation, and it is a reasonable supposition that caribou long ago adapted to that fact of life. Indeed (it) may legitimately be asked if periodic fires do not improve the caribou wintering range in both the short and intermediate terms by mineralizing nutrients and reviving the growth of sedges, forbs, shrubs and even lichens".

Snow conditions also have a profound effect on caribou movements and distribution. In Newfoundland, Bergerud (1963, 1967) observed that woodland caribou tend to disperse over extensive areas in winter of little snow and concentrate where snow is shallowest during severe winters. Thomas (1967) felt that wintering range sought by different herds of barren-ground caribou was probably determined by climatic conditions and particularly by snow quality. Pruitt (1960) in his studies of barren-ground caribou on northern Saskatchewan and Manitoba ranges, strongly emphasized the importance of snow quality to caribou. His findings suggest that their nomadic behaviour and ability to use most elements of their range occurs in response to changing snow conditions. For example, he states that by opening craters, caribou disturb the snow cover causing it to set which makes it unsuitable for subsequent foraging. As a result, caribou will feed only once more in a previously cratered area before moving on to fresh sites.

Snow depth, hardness and density values obtained on two sites in the Kettle Rapids map area are presented in Table 3 (ranges given for hardness and density reflect quality changes between distinguishable layers of snow). I present these figures only to indicate what snow conditions <u>might</u> have been like on similar landforms used by caribou in the Hayes river map area during March 1975. Obviously, extensive sampling is required to determine when snow characteristics are associated with caribou concentration and non-use areas. Pruitt (1959) stated that ideal snow conditions for caribou in forested habitats should have: a hardness not greater than $60 g/cm^2$, a density not exceeding 0.20, and a depth less than 50 to 60cm.

Table 3: Snow quality values for a peat plateau and horizontal fen in the Kettle Rapids map area.

Measure	Site: Peat Plateau	Site: Horizontal Fen
Hardness (g/cm^2)	10 - 20	10 - 80
Density	0.14 - 0.24	0.09 - 0.26
Depth (cm)	56	59

Data obtained in the present study and from the literature indicate that much of the Hayes River map area provides suitable, and in some cases, high quality winter and summer habitat for woodland caribou. From examination of landform and vegetation data, I conclude that the French River Land District, and to a lesser extent, the Wigwam Creek Land District, provide the highest capability caribou habitats available in the map area. Land systems within these districts contain many beach ridges, marine plains, drumlins and alluvial deposits interspersed with bogs, fens, and in the French River district, numerous shallow lakes. Such features are characteristic of good caribou summer and winter ranges in other parts of North America. Plant species considered important as caribou food in other regions are abundant throughout most of the map area. Although more intensive study is required before

a reasonable estimate of carrying capacity can be made, it would appear that, in winter, the last areas (ie French River Land District) could support up to one caribou/eight acres as cited by Pruitt (1959 in Kelsall, 1967) for productive barren-ground caribou range.

Moose

Only five moose and 45 track sightings were recorded on the winter censuses. Animals and tracks were scattered throughout the area and were not concentrated in specific land systems or land districts. However, the data do indicate a preference for particular landforms or habitats within land systems (Table 1). Of the 45 sightings, 33 (73%) were along river or creek channels and in water-track fens; willow and dwarf birch growth were the dominant plant species on 75% of these sites. Aspen dominated on two sites (4%) with well-drained alluvium.

The Hayes River map area clearly provides less than ideal winter range for moose. The deep organic soils that blanket most of the area favour growth of low evergreen shrubs (primarily Ericacaea) on bogs and low forb-shrub vegetation in fens. Although many of the species found on organics are palatable to moose, most are covered by snow in winter and are therefore unavailable. Deciduous shrubs, such as willow or dwarf birch, are largely confined to better-drained alluvial deposits and nutrient-rich water-track fens but may also occur on well-drained mineral landform following fire. Post-fire regeneration on organic sites tend to be impoverished and almost never provided browse species favoured by moose.

We recorded few moose in the area between August 18 and 28, 1974. Animals were observed in fens or in shallow water near lake shores. As with caribou, the lack of moose sightings in forested areas was attributed to the concealing effects of vegetative cover; consistent but rarely abundant sign on upland habitats showed that moose were not confined to wetland and aquatic sites.

In winter, moose prefer subclimax habitats with numerous openings and shrublands interspersed with mature forest stands which provide shelter (Table 4). Disturbed sites such as burns and cutovers that supply good deciduous regeneration are used for feeding during all seasons.

Of the forage species eaten by moose at various times of the year willows appear to be the key winter foods on western ranges, especially in mountainous terrain, whereas, in eastern North America, a mixture of hardwoods including maple, aspen, ash and brich are most important along with balsam fir in some areas. Peek (1974), in his review of moose feeding habitats in North America, noted that balsam fir, aspen, white birch and red-osier dogwood are preferred on Canadian ranges. He points out, however, that because of biases associated with food habits studies and because forage use varies with intensity of browsing, time of year, species composition and moose populations on different ranges, comparisons between different geographic areas must be made with great care.

Compared to the moose ranges described in Table 4, habitats in the Hayes River map area are decidedly impoverished in terms of forage diversity. Aside from the scattered stands of willow and alder along drainage ways, there is precious little browse available to moose in winter. Examination of vegetation data revealed that highly palatable species such as aspen and white birch are practically non-existent in the area and are uncommon even on recent burns.

The most promising moose range from a vegetation-landform point of view is in the southeastern portion of the map sheet (Wigwam Creek and French River Districts) and along the Hayes river and its major tributaries. These areas provide a varied relief pattern (beaches, drumlins, bogs and fens) and rich alluviums supporting vigorous willow-alder growth and occasional stands of white birch and aspen. According to H. Veldhuis and G. Mills (personal communication), drumlins and beaches contains a richer deciduous growth than is found in most other parts of the map area. The fact remains, however, that only two moose and little sign were observed in these areas during both winter and summer studies. Several factors may be responsible for this. First, the study area lies near the northern limit of moose range (see Weir, 1960) so one would not expect to encounter high population densities there. Second, the better upland mineral sites are bounded by extensive organic deposits that are largely unattractive to moose and may act as barriers to movement. Third, compared to areas lying farther south and west, even the most productive habitats in the Hayes River map sheet are of marginal value.

Snow depth is considered a major factor influencing the winter distribution of moose. Telfer (1967) felt that snow deeper than about 90 cm seriously hindered movement while Nasimovitch (in Telfer, 1970) considered 60 to 70 cm of snow to be restrictive. In Quebec, Desmeules (1964) found that snow depths of 77 to 86 cm caused moose to leave cutovers for

Table 4: *General characteristics of moose winter habitat in North America.*

Area	Habitat Characteristics	Source
Alaska	Glacial and riparian seral communities are most important; willows are key browse species; burns are also valuable	LeResche et al (1974)
West-Central Manitoba	Highest moose densities occurred on gently sloping till plains interspersed with organic deposits; in wet areas with willow-alder stands; on uplands dominated by aspen, white birch, balsam poplar; and, in burns. Coniferous forests and muskegs were less important	Hildebrand and Jacobson (1974)
N. Saskatchewan and Manitoba; S. District of Mackenzie	Heaviest use occurred in one to 50 year old burns; preferred browse species were willows	Scotter (1967)
Isle Royale, Michigan	Post-fire regeneration in mixedwood forest is most important; white birch and aspen the dominant deciduous species with red-osier dogwood, willow, rose, alder, mountain maple, juneberry, mountain ash and highbush cranberry present in different stands; mature sugar maple-yellow birch forest was less important	Drefting (1974)
Quebec	Southern exposures with moderate slopes are preferred as are sites disturbed by fire, logging or insects. Deciduous-boreal transition and southern boreal forest zones support the largest numbers; important browse includes mountain maple, balsam fir, hazel, red maple, willow, white birch	Brassard et al (1974)
New Brunswick	Moose prefer gently sloping lowlands cut by broad stream valleys and separated by low uplands; open deciduous and coniferous stands (old burn) are used more in mid-winter; dense conifers may be important in late winter. Deciduous species include maples, birches and aspen; conifers are spruce, balsam fir, tamarack, white cedar, pine and eastern hemlock	Telfer (1970)
Newfoundland	Spruce-balsam fir forest interspersed with burns, clearcuts, lakes and shrub barrens	Bergerund and Manuel (1969)
NE Minnesota	Extensively burned tills and peat lowlands supporting a mixture of aspen, spruce, white birch, balsam fir and jack pine in various age classes	van Ballenberghe and Peek (1971)
NW Minnesota	Prairie-mixedwood ecotone featuring marsh, willow stands, hardwoods and abandoned fields in different stages of succession	Phillips et al. (1973)
Montana	Mountainous terrain; moose prefer upper slopes (above 7,500 feet) if snow is not deep but concentrate in willow bottoms during severe winters	Knowlton (1960)
Jackson Hole, Wyoming	Cottonwood and willow growth along river valleys	Harry (1957)
Nova Scotia	Extensively clearcut forest dominated by softwoods and heavy shrub growth consisting mostly of <u>Rubus</u> and <u>Ribes</u>; maples are heavily used	Telfer (1967)
Gallatin Mountains, Montana	Mountain-foothill terrain (5,000-10,000 feet). Douglas fir, lodgepole pine and spruce-fir communities are important in early winter; aspen communities are used in mid-winter. Lowland aspen and willow stands received late winter use.	Stevens (1970)
Montana-Wyoming	Riparian communities dominated by willows mixed with alder, red-osier dogwood and silverberry; conifer stands are used for bedding and escape; terrain is mountainous	Peek (1974)
South-central Alaska	Disturbed areas with willow-birch growth or aspen regeneration support the densest moose populations	Spencer and Chatelaine (1953)

denser forest cover and that 90 to 120 cm depths were "critical". In the relatively dry northern boreal climate of the Hayes River area, snow depth in itself does not appear to be especially restrictive. My own limited examination of snow conditions just outside the map area in March 1975 showed accumulations to be about 55 to 60 cm deep. None of the animals we spotted appeared to have any difficulty running when startled by the aircraft.

Studies of summer food habits suggest that moose eat a greater proportion of forbs, graminoids and aquatics than they do in winter (Peek, 1974; Stevens, 1970; Ritcey and Verbeek, 1969; LeResche and Davis, 1973; Dodds, 1960), although browse remains the dominant source of food in most areas. The importance of aquatic forage varies from area to area. In Ontario and Minnesota, both emergents and submergents receive heavy summer use (van Ballenberghe and Peek, 1971; DeVos, 1960), whereas in Newfoundland and Yellowstone Park, aquatics are of little importance probably because of their low availability (Dodds, 1960). Peek (1974) notes that yellow water lily (Nuphar variegatum), pondweeds (Potamogeton spp.) and horsetails seem to be preferred wherever they occur. In the Hayes River map area, the richest forb-graminoid growth occurs in fens. Virtually all of these sites, particularly those bordering lakes or streams, were crossed by numerous ungulate trails. Sparse growths of yellow water lily, horsetail and occasionally pondweeds were present in most lakes and impeded drainages. We frequently observed tracks, presumably those of moose, in many of the shallow, muck-bottomed lakes typical of the area.

Table 5: Waterfowl observed in the Angling River and God's River lake clusters, August 18 to 28, 1974.

Species	No. of Waterfowl (% of Occurrence) Cluster A	Cluster G
Canada Goose	24 (4)	78 (12)
Mallard	0 (0)	7 (1)
Green-winged Teal	11 (2)	29 (4)
Scaup	117 (38)	273 (42)
Common Goldeneye	10 (2)	2 (tr)
Scoter	174 (30)	114 (17)
Common Merganser	14 (3)	3 (tr)
Unidentified Diving Duck	63 (11)	117 (18)
Unidentified Duck	58 (10)	34 (5)
Total	571 (100)	657 (99)

Although moose occur in the Hayes River map area, they are present in very low densities (estimated at not more than one moose per 21 square miles, assuming all animals were recorded within the observers one-eight-mile-wide census strip). In general, the area lacks most of the deciduous browse species favoured by moose; what browse is available is largely confined to small drainages interspersed with large, unproductive bogs or fens. Such lack of diversity, both in vegetation and landform, indicate the Hayes River map sheet has an extremely low capability for moose production.

Waterfowl

I counted 1,228 waterfowl on 87 water bodies in the Angling River (A) and God's River (G) lake cluster (Table 5). Scaup and scoters were first and second in abundance in both areas, and along with Common Mergansers (Mergus merganser), were the only duck species recorded as having broods. Of the 217 scaup in Cluster A, 123 (57%) were young, while 94 ducklings (34%) of 273 scaup counted were recorded in Cluster G. The number of young scoters in Group A was estimated at 62 (61%); in Group G, 15 (13%). The disparity in the abundance of immature scoters between the two areas may be more the result of observer error than of any real difference in the young-adult ratios. At the time of the surveys, scoter broods were in close-knit gang broods of 15 to 50 ducklings which made precise counts difficult to obtain. Scoters always dove and scattered when disturbed by the helicopter, thereby adding to the bias in the estimate. The tendency of many birds to dive also explains the sizeable "unidentified" categories and accounts for my failure to distinguish many scaup and scoters by species; when I was able to make positive identifications, they invariably turned out to be Lesser Scaup (Aythya affinis) and White-winged Scoters (Melanitta deglandi). Only 17 Common Mergansers were observed in the two lake clusters and 12 (70%) were immature.

Waterfowl were recorded on 39% of the lakes surveyed in Cluster A and on 56% in Cluster G. The number of birds per water body ranged from one to 163 and averaged 14 for all sample lakes in the combined clusters. The average number of waterfowl observed on lakes with at least one bird was 30 in each cluster.

There was a highly significant correlation (P.01) between waterfowl numbers and lake surface area (r 0.70 and 0.73) for Clusters A and G respectively . The relationship between

waterfowl and shoreline development was also significant (P .05), although the "r" values were considerably lower (0.32 and 0.35). It would appear, then, that waterfowl at this time of year prefer large lakes with irregular shorelines over small lakes with smooth shorelines.

Except for some of the younger broods, rafts of scaup, scoters and Common Goldeneyes (Bucephala clangula) frequented open water areas away from shore. The few Green-winged Teal (Anas carolinenis) and Mallards (A. platyrhynchos) occurred in sparse emergent vegetation immediately offshore; Common Mergansers were observed near shore but in areas having little or no aquatic vegetation. Seven of the eight Canada Goose (Branta canadensis) flocks were in open water on larger lakes (110 to 723 ha), while the other group, a flightless brood flock of 26, was observed in thick sedges lining the sore of a nine hectare lake. G. Mills, D. Forester and H. Veldhuis (personal communication) observed two other goose flocks in sedge-dominated fens, suggesting that a survey confined to lakes is not a particularly effective method for determining the distribution of Canada Geese, especially those with young. It should be noted that the first seven flocks consisted of postmoult adults and that the goslings in the brood flock were nearly grown.

Neither lake cluster was used much by adult diving ducks (ie scaup and scoters) for moulting. I counted only a few males mixed with brood flocks and non-breeding females and it was always difficult to tell if birds were flightless because of their tendency to dive when disturbed. In contrast, I later observed many large rafts of moulting and staging scaup (but comparatively few Scoters) in the large, turbid lakes to the west of the Hayes River map area. It appears then, that the smaller, organic-dominated water bodies in the study area are used to a limited extent for breeding and brood-rearing rather than for moulting and staging.

Waterfowl densities per unit surface area of water were extremely low: 0.14 birds/ha in Cluster G and 0.09 birds/ha in Cluster A. The difference indicates that the God's River cluster provides slightly better habitat conditions during the post-nesting period than Angling River cluster. Results of water analyses for 12 lakes in Cluster A and 11 lakes in Cluster G (Table 6) indicate water quality differences exist between the two areas as determined from paired t-tests. In general, lakes in Cluster G tended to be harder than those in Cluster A.

On two helicopter surveys of the Hayes River from its mouth to God's River on August 23 and 24, 1974, I recorded the following: 73 Canada Geese, seven Mallards, five white-winged Scoters, two Green-winged Teal, and 29 unidentified ducks on August 23, and 100 Canada Geese, five Lesser Scaup, six Mallards and two common Mergansers on August 24. Most of the geese were located in or next to a small rapid immediately upstream from the mouth of Pennycutaway River.

On August 28, I surveyed the entire length of the Nelson River within the Hayes River map area and saw 120 Canada Geese, one Red-breasted Merganser (Mergus serrator), one Common Merganser and a brood of 10 Lesser Scaup. All but three of the geese were loafing on tidal mudflats near the mouth; no

Table 6: Water chemistry analysis for Angling River and God's River lake clusters, August 1974.

Lake Cluster	Parameter (Mean and Range Values)							
	Cl* Mg/l	SO mg/l	Na mg/l	K mg/l	Mg* mg/l	Ca* mg/l	pH	Conductivity** UMHO/cm
Angling River (A)	2.0	2.5	1.8	0.18	1.9	10.7	7.2	74.6
n 12	(1.0-3.2)	(1.8-4.0)	(1.1-2.6)	(.11-.28)	(1.2-4.4)	(5.2-22)	(6.5-7.9)	(50-150)
Gods River (g)	1.6	2.1	2.0	0.20	2.7	17.0	7.3	100.4
n 11	(0.8-2.2)	(1.403.2)	(1.4-2.6)	(.11-.23)	(1.8-5.4)	(10.1-38.7)	(6.4-8.1)	(60-225)

* Significant (P<0.10) ** Significant (P<0.05)

waterfowl were seen west of Deer Island.

Jahn and Hunt (1964) demonstrated that in Wisconsin, breeding populations of waterfowl are much larger in sedimentary regions having hardwater wetlands than in the softwater habitats typical of the Precambrian Shield. Patterson's (1972) study of waterfowl-wetlands relationships in eastern Ontario showed that ducks require different types of water areas at different times of the year. Breeding pairs were more influenced by pond morphometry (size, shoreline configuration, distribution) than by pond fertility; staging flocks, however, congregated on hardwater ponds without regard to their morphological attributes. Broods fell somewhere between, preferring fertile waters with shoreline characteristics that provided suitable escape cover. Patterson (1972) also observed that the presence of brood flocks was positively correlated with high concentrations of calcium and chloride ions, conditions characteristic of ponds in sedimentary substrates but not in those overlying Precambrian rock. His values for calcium in hardwater ponds of sedimentary origin are consistently higher (33-43 mg/l, x 38 mg/l) than values we obtained for lakes in in the Hayes River map area (5.2-38.7 mg/l, x 13.7); calcium concentrations in his Precambrian ponds (7.6-28.2 mg/l, x 14.1) appear roughly equivalent to the Hayes River figures. He reported that densities of broods and fledged ducks were low or nil on Precambrian ponds, however, his density figures were still higher than those obtained on our sample lakes. In another paper, Patterson (1970) stated that calcium appeared to be the best indicator of pond quality for waterfowl.

Compared to hardwater wetlands in the prairie pothole region, lakes in the Hayes River map area are extremely low in fertility. Dwyer (1970) found that small wetlands in woodland and farmland areas of southwest Manitoba had specific conductances ranging from 366 to 4,770 umhos/cm, with highest values occurring in agricultural wetlands. In the Hayes river area, conductance values, which reflect quantities of total dissolved solids, varied from 50 to 225 umhos/cm.

Beard (1964) reports that the young of most duck species rely almost entirely on animal foods during the first two weeks after hatch. Krull (1970) further states that egg-laying females, ducklings and moulting adults are probably unable to obtain sufficient protein from plants alone. However, he demonstrated that, ". . . macroinvertebrates were at least several, and probably many, times more abundant in vegetated areas than in non-vegetated areas." Krull estimated softwater lakes may average 500 kg of bottom flora/ha, whereas hardwater lakes could support ten times that amount. Assuming that relative abundance of aquatic vegetation is an indicator of food production, it appears that lakes in the Hayes River map area, being poor in aquatic plants, are of marginal value to waterfowl during the critical brood, moult and staging periods.

The Hayes river map area lies near the centre of the breeding range of the Eastern Prairie Population of Canada Geese (B.c. interior). Compared to the coastal tundra habitats near Cape Churchill, nesting densities in the bog-fen terrain of the Hayes River area are low. Malecki (1974) reported goose nest densities of 3.9 to 5.8/miles^2 on the coastal tundra and only 0.5 to 0.8/mile^2 on lowland habitats typical of the Hayes River area. Pakulak and Schmidt (1970) have also indicated that the most intensively used areas for nesting lie along a narrow strip of coastal tundra-forest transition between Broad River and Cape Churchill and what areas further inland support uniformly low nesting population.

Major rivers are important to Canada Geese during spring staging and brood rearing periods. When geese first reach the breeding grounds in early spring, the only open water available is in rapids of larger rivers. Such sites become especially important when low islands and sand bars are available for resting and loafing. In late summer, broods move down river from inland breeding areas to estuaries and tidal flats along the Hudson Bay Coast (Hanson and Smith, 1950; Pakulak, 1971).

Other Wildlife Species

Beaver (Castor canadensis) appeared to be fairly common throughout the Hayes River map area. During winter surveys, I observed beaver houses in virtually all water-track fens, small creeks and along lake margins that supported a thick growth of willow and dwarf birch, however, the majority of houses appeared to be old and long unused. I also recorded six sets of wolf (Canis lupus) tracks and two additional tracks identified as belonging to either fox or wolf. Four of the six wolf trails were located in the French River Land District in areas exhibiting the most recent and heaviest caribou use; track patterns indicated that rivers, creeks and lake shores are preferred travel routes for wolf and fox. The only other fur-bearer I observed was an otter (Lutra canadensis) on the Pennycutaway River.

Trapping data from the Limestone and Shamattawa Registered Trapline Districts are presented in Table 14. Information for the

Shamattawa District, which covers the eastern two-thirds of the Hayes River map area, was not available by individual blocks, therefore, the figures given refer to entire district areas and not just to those segments in the Hayes River map sheet. I include these data only to show that fur-bearers are a potentially valuable resource in this part of northern Manitoba. A reliable assessment of populations and distribution of fur-bearer species in the area would require costly and time-consuming field studies which, for the most part, are beyond the scope of a reconnaissance investigation such as NRIP.

Several flocks of ptarmigan and a flock of 15 Sharp-tailed grouse (Pediocetes phasianellus) were seen in willow-dwarf birch habitats associated with creeks and watertrack fens. According to Godfrey (1967) Willow Ptarmiogan Lagopus lagopus) inhabit the Hayes River area year-round, as does the Sharptailed Grouse; Rock Ptarmigan (L. mutus) may inhabit the area in winter but probably not on an annual basis or in large numbers. Of all tracks observed during winter surveys, those of grouse were by far the most abundant and I presume the majority were made by Willow Ptarmigan. All three species favour shrubby areas or forest openings as opposed to mature forest. Spruce grouse (Canachites canadensis), on the other hand, we often found in mixedwood and spruce-pine forests although they too frequent openings, burns and shrublands. I noted grouse droppings (presumably those of Spruce Grouse) on all upland sites I visited in summer, including bog veneers, old beaches and peat plateaus.

Surprisingly, few songbirds (Order: Passeriformes) were recorded in late summer. At this time of the year most birds are quiet and inconspicuous and therefore difficult to see and identify. Species observed on beach and peat plateau sites included gray jay (Perisoreus canadensis), Rusty Blackbird (Euphagus carolinus), Tennessee Warbler (Vermivora peregrina), Boreal Chickadee (Parus hudsonicus) and Darkeyed Junco, slate-colored race (Junco hyemalis hyemalis). On two reparian sites I recorded Tenessee Warbler, Yellow Warbler (Dendroica petechia), Common Raven (Corvus corax), Spotted Sandpiper (Actitus macularis), Yellowlegs and Herring Gull (Larus argentatus); two Ospreys (Pandion haliaetus) were observed foraging near the mouth of Hayes River, one on August 23 and the other on August 27. R. Bukowsky (personal communication) saw a breeding pair of Sandhill Cranes (Grus canadensis) plus several non-breeders in a large patterned fen approximately three miles east of York Factory.

During August waterfowl surveys, I counted 161 Common Loons (Gavia immer) on 52 of the 87 sample lakes. Numbers ranged from one to 13 per water body but the majority occurred as pairs (22 instances); two of the pairs each had two very small downy young. Also recorded on waterfowl counts were 12 Yellowlegs, two Common Ravens, 24 Bonaparte's Gulls (Larus philadelphia), one Black Tern (Chlidarias niger), five Spotted Sandpipers, 34 Herring Gulls, three American Bitterns (Botaurus lentiginosus, in G cluster only), nine unidentified terns, presumably Common Terns, and one unidentified Buteo hawk.

GENERAL CONCLUSIONS

Compared to many other parts of northern Manitoba, the Hayes River map area, with its extensive organic deposits, its low relief and limited variety and interspersion of mineral landforms, must be rated low in productivity for most wildlife "game" species. The area does, however, provide high quality winter and summer habitat for woodland caribou. Some of the better sites in the French River District probably have a winter carrying capacity approaching the one caribou per eight acres figure projected for "best" barren ground caribou ranges (Pruitt, 1959 in Kelsall, 1967).

A better idea of the general productivity of the Hayes River map area can be obtained through comparison with other map sheets. Preliminary examination of moose and caribou data from winter surveys in the Kettle Rapids map area shows that as one moves out of the lichen-rich landforms of Hayes and into the till-lacustrine dominated terrain typical of Kettle, the amount of caribou sign drops off dramatically. In fact, no caribou sign was recorded on nine of the 17 transects surveyed in Kettle and the total number of sightings was only 29 compared to 125 in Hayes. Moose, on the other hand, were more abundant, both in numbers of animals seen (16) and total track sightings (108), in Kettle. Although no vegetation analysis has been done, the amount of deciduous browse species such as white birch and alder is clearly greater in Kettle than in Hayes. Burns in Kettle also produce more useable browse than those observed in Hayes.

The Hayes River map area obviously supports very low densities of breeding waterfowl. Again, comparison with the Kettle Rapids area is instructive. Most of the Kettle lakes are underlain by mineral soils of till or lacustrine origin and appear to have significantly greater conductance readings and calcium and conductance for Kettle water bodies are 19.4 and 133, respectively. The total number of waterfowl observed on 22 lakes in

Kettle was approximately 10,000 compared to 1,200 on 87 lakes in Hayes. In addition, more individuals (811) and species (14) of surface-feeding ducks were counted in the Kettle area. Unfortunately, the land-wildlife information gathered on the four map areas studied in 1975 has yet to be analyzed so that comparisons with these areas cannot be made at this time.

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WILDLIFE HABITAT INVENTORY AS ACCOMPLISHED BY THE UNITED STATES BUREAU OF LAND MANAGEMENT

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ABSTRACT

The Bureau of Land Management (BLM) is responsible for the protection and management of wildlife habitat. Rational management decisions require an inventory which locates and quantifies the amount of wildlife habitat on public lands. This paper summarizes the BLM's rationale for and methodology of wildlife habitat inventory.

RÉSUMÉ

Le bureau de la gestion des terres est chargé de la protectiont de la gestion de l'habitat faunique. Pour prendre des décisions rationnelles, en matière de gestion, il faut qu'un inventaire établisse l'emplacement et la quantité des habitats fauniques situés sur les terres publiques. Le présent document résume la raison pour laquelle le bureau de la gestion des terres a effectué un inventaire des habitats fauniques, ainsi que les méthodes qu'il a utilisées à cette fin.

INTRODUCTION

The Bureau of Land Management manages approximately 60 million ha of federally owned public land in the lower 48 states, and around 120 million ha of public lands in Alaska. These are the lands upon which we have surface as well as subsurface management responsibilities We also have other responsibilities where the federal ownership of subsurface mineral is separate from the private surface ownership. Management of these surface-owned lands included such things as timber sales, livestock grazing, mineral leasing and sales, outdoor recreation activities, cultural and historic preservation, various types of protection, and the management of wildlife habitat.

We believe that one of the primary steps to be taken in terrestrial wildlife habitat management is an inventory that will quantify the amount and show the location of habitat on the public lands for all vertebrate species which occur there. Our experience up until the middle 1960's was mostly with the management of habitat for big game species such as elk, mule deer, mountain goats, bighorn sheep, and antelope (pronghorn). With the passage by our Congress of the National Environmental Policy Act of 1969, the Endangered Species Act of 1973, and our own (BLM) Organic Act of 1976, we have been required to not only consider large animals, but as previously stated, all vertebrate species and a few invertebrates in the decisions affecting the management of the public lands. In addition, several interest groups have brought suit against the Bureau of Land Management in the Federal courts. Pertinent court decisions and orders have further emphasized the need for this comprehensive wildlife habitat inventory.

CORRELATION OF SOIL-VEGETATION INVENTORY WITH WILDLIFE HABITAT INVENTORY

The first step in our soil-vegetation inventory is to map, using 1:24,000 scale aerial photography, the soils to the series level for the study area in which we are working. This scale of accuracy has been deemed necessary because of requirements of our livestock grazing and wildlife programs. We must allocate existing forage between domestic livestock and wild ungulates and at the same time thrust the succession of vegetation in the direction desired for the habitat of smaller animals.

This soil inventory is normally done in the first year of the inventory effort. After the soils have been mapped, perhaps in the second year, those soils having the potential vegetation by production and species composition are lumped into range site delineations. These range sites are standardized by region and normally conform to landform boundaries on

the ground. The range site is defined as "a distinctive kind of rangeland which differs from other kinds of rangelands in its ability to produce a characteristic natural plant community" (Shiflet, 1973). It is at approximately the same level as the habitat types attributed to Daubenmire and like these is characterized by the potential plant community of the site, rather than the existing vegetation (Daubenmire, 1968).

Because of past land use, mostly the grazing of livestock, the total area of range sites will not reflect the same vegetation conditions. Some areas which have been grazed heavily will not be producing climax or high seral stages of vegetation but will be producing lower seral stages. These condition classes for all of the standard range sites are given rating of poor, fair, good or excellent. It might be well to consider these descriptors as low, mid, high or climax seral stages.

Because the seral stage descriptors are based upon the percentage of species found which are in the climax condition, it is possible to have two different existing plant communities on one condition class within a range site. Therefore, we must further delineate the condition class into different existing plant communities. When this final delineation has been made, each of the polygons is given a specific and unique number and we call this final polygon a site write-up area. These site write-up areas are then stratified by range site, condition class, and existing community, and are sampled for vegetation. The vegetation sampling includes the production of vegetation by weight, the vigor and height of vegetation as determined by characterization plots (age and form class), and the layering and percent composition as well as cover percentage as determined by a 200 pace transect (BLM 1731, 1979).

These site write-up areas or cells with their vegetation characterization are then used as a basis for the wildlife habitat inventory.

Since we have two types of animals, sedentary or obligate animals as opposed to habit-driven or mobile animals, we will use the cells or site write-up areas in two ways to fulfill the requirements of these two kinds of animals.

I should now like to further explain how these cells are used in the habitat inventory. As previously stated our inventory of habitat must be for all vertebrate species in the area of study. This may involve as many as three to four hundred species within the jurisdiction of one of our district offices. After reviewing the literature we find that major factors which affect the occupancy and type of use made of a piece of land by an animal are 1) Whether water occurs in or near the area; 2) What kind of landform the area is composed of (is it on a mountainside, on an alluvial plain or in a valley); and 3) What type and amount of vegetation exists there. These characteristics might be called the physiognomy of the habitat site (Kerr and Brown, 1977).

Having delineated the homogeneous cells of vegetation and landform (site write-up areas) in our soil-vegetation inventory, we now need to know certain facts about these cells. First of all, we have mapped the cell boundary. Now we must know the area of the cell. We feel that the use of 1:24,000 aerial photographs and maps gives us the accuracy for delineating and measuring the cells we need in our management work. This is especially helpful, since this is the scale of our U.S. Geological Survey Topographic Maps.

We must know certain facts about the vegetation that exists within the cells. The items which are measured in the vegetation inventory are:

1) percent composition of the cover by species

2) total percent of cover;

3) crown cover percentage of shrubs and trees;

4) the vigor or age and form class of the plant species; and

5) the structure of the vegetation.

By structure we mean the conformation of the vegetation as seen in an overhead view of a forest. Overhead structure is much the same as the percentage of canopy cover. The second form of structure is a horizontal view standing on the ground and noting the conformation including layering of the vegetation. The importance of the overhead vegetation structure can be emphasized; for example, on very hot days in the Socorro, New Mexico area, black-tailed jackrabbits will be found only in the shade of the cholla cactus. Furthermore, scaled quail use the overhead protection or structure of the vegetation for protection from hunting raptors. It would not matter to the quail if the protection came from a cholla cactus or a creosote bush. The structure is the same.

The next category of information necessary is information concerned with the local landform of the cell. In this regard, we need to know information on:

1) percent slope;

2) aspect;

3) elevation; and

4) landform description (valley, hill, mountain).

Now that we have the delineated cell along with the characterization of vegetation and landform, we need to know the following wildlife values occurring within the cell:

1) animal species occurrence;

2) use being made by each species;

3) verification of species occurrence;

4) ties to ecotones of neighboring cells;

5) general abundance of the occurrence of each species; and

6) special features such as watering areas for all animals, caves for bat roosts, and such things as highway bridges which may provide nesting areas for swallows. These special features would not normally be displayed in the soil-vegetation inventory.

Based upon the foregoing explanation, we can for sedentary and obligate animals which are ubiquitous within specific vegetation community and landform types, stratify similar individual cells into what we call standard habitat sites. Sample areas of these standard habitat sites can then be sampled and the information extrapolated to the unsampled cells thereby characterizing this portion of the animal community occurring in the standard habitat sites (BLM 6602, 1978).

We normally sample in at least two areas of a standard habitat site for these smaller animals. The samples within the standard habitat sites are made for the various classes of animals and at the important season. In the Southwestern United States, we might sample for amphibians and reptiles in the spring, song birds in spring and winter, and small mammals in the summer. Sampling methods are devised to give occurrence and relative abundance, rather than population information. In most cases, sampling times and techniques must be selected based upon the class, genera, or species of animal to be verified by sampling. There are two other factors which will affect the occurrence of large mobile animals within these sites. That is, that these larger, or mobile, or habit-driven animals will not routinely appear in all similar plant communities or standard habitat sites.

The first factor that affects this phenomena is the juxtapositional value of the cell. An example of this is found in Jackson Canyon just west of Casper, Wyoming. In this area eagles were roosting in mature and old ponderosa pine trees in the canyon and adjacent to it, we would have mapped about 4000 ha. The eagles, however, were historically using only 81 ha of these trees. The reason for picking this particular 81 ha was because the ridge upon which the 81 ha occurred was in close proximity to a well-grazed sheep range which provided a good small mammal prey base for golden eagles. It was also adjacent to the North Platte river which offered a hunting area for bald eagles. Jackson Canyon provided a late afternoon thermal updraft upon which the golden and bald eagles rode to their preferred ridge which had no access and prohibited human disturbance. The value of this wooded ridge was brought about by the characteristics of its neighbors. These kinds of values may be referred to as juxtapositional values.

The second characteristic which must be considered is the propensity of larger mammals to acquire learned behavioral patterns. These patterns can only be determined by field inventory. In Colorado, at the 2700 m elevation in the mountains where rolling hills occur and quaking aspen give shelter along a winter-summer migration route in close proximity to water, we would expect to find elk calving areas. However, the only areas of this description which would actually be elk calving grounds would be those that elk have learned to use traditionally year after year. This is true of sage grouse in their wintering and summering areas, as well as many other species. It is especially true of mule deer which will pass up areas of excellent forage on a winter range to return to their traditional winter ranges which contain less desirable forage. This behaviour is common to most large ungulates, including mule deer, elk, moose, antelope, but not barren ground caribou (Kerr, 1978).

For these two reasons, juxtapositional values and learned behavioral patterns, we do not sample standard habitat sites for large or mobile or habit driven species. For these species (ie deer, elk, beaver, nesting raptors, wolverine, etc.) we examine each individual cell (site write-up area or habitat site) in the field by an appropriate method (see Table 1 for examples). The various State wildlife agencies are normally used as a first source of information, especially on game species. Any study done on populations of these species is invariably performed in cooperation with these agencies. Population information is necessary to allocate existing forage.

One additional tool used in evaluating and providing general descriptions is a regional-

Table 1: Techniques used to verify big game occurrence within habitat sites.

TECHNIQUES / SPECIES	STATE AGENCY RECORDS*	ANIMAL OBSERVATIONS Via: Fixed-Wing Aircraft	Helicopter	Ground Inspection	TRACK CONCENTRATIONS AND WALLOWS	BROWSE FORM CLASS	PELLET CONCENTRATIONS	TREE RUBBING, TEETH MARKS, ROOTING, ETC.	MONITORING ANIMALS At: Salt Licks	Watering Holes
Mule Deer (Odocoileus hemionus)	X	X	X	X	0	0	X	0	0	0
White-tailed Deer (Odocoileus virginianus)	X	?	?	X	0	0	0	?	?	?
Elk or Wapiti (Cervus elaphus)	X	X	X	X	0	0	0	0	?	0
Proghorn Antelope (Antilocapra americana)	X	X	X	0	0	0	?	?	?	0
Moose (Alces alces)	X	X	X	X	0	?	0	0	?	X
Bighorn Sheep (Ovis canadensis)	X	0	0	X	0	?	0	?	0	X
Javelina or Peccary (Dicotyles tajacu)	X	0	X	X	0	?	?	0	?	0

Legend: X - primary tool 0 - useful ? - of questionable use for this species

* General herd locations

ized ecosystem cover type formed by a group of field cells having similar vegetation potential. For this, we have used A.W. Kuchler's map of the natural potential vegetation of the United States (Kuchler, 1964). The use of habitat types or range sites as a description of the potential of the site lends more accuracy to potential descriptions which are helpful in the management planning of the site write-up areas.

Even though it is important to know the potential plant community that a cell will produce, the most important thing to know is what the existing vegetation is at present. An example of this is this picture of a Rocky Mountain elk feeding in herbaceous vegetation which will one day produce a patch of douglas fir trees. The fact that trees will one day stand here is not important. The important thing to the elk is that today it produces succulent forage for its consumption.

If the cells described and the information required are all obtained, then a factual analysis can be made for most vertebrate species as to whether any area so inventoried provides habitat for a particular species, how much habitat is available, what condition it is in, which way it is trending, whether it is suitable, etc. Many analyses, indices, and other necessary information can be obtained from a wildlife habitat inventory based upon a soil-vegetation (biophysical) inventory if the data elements or parameters of such inventories are properly designed to capture the necessary factors.

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ECOLOGICAL LAND CLASSIFICATION HIERARCHIES AND ELK DISTRIBUTIONS IN SOUTHWESTERN ALBERTA

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ABSTRACT

Winter elk distribution data and an ecological land classification hierarchy are compared. The comparison reveals that elk have a preference for the Montane Ecoregion and grass covered southerly aspects which occur in proximity to coniferous stands in southwestern Alberta.

RÉSUMÉ

D'après des données sur leur répartition en hiver en regard de la classification écologique des terres, les Wapitis préfèrent la région écologique "montagnard" et les herbages exposés au sud, près des peuplements de conifères du S.-O. de l'Alberta.

INTRODUCTION

The incorporation of wildlife information into ecological land survey work by the Resource Appraisal Section has been limited due to a variety of logistic and technical reasons. The major reason is the length of time required to collect sufficient wildlife data compared to a one year time frame allowed to conduct an ecological land survey. As a result, the ecological land survey and wildlife data in this study were collected independently. The survey was produced as an ecological base for long-range integrated management planning of natural resources. Wildlife information was collected as part of an inventory program by the Fish and Wildlife Division, Alberta Energy and Natural Resources.

The purpose of this paper is to compare winter distributions of elk (Cervus canadensis) with an ecological land classification in the Livingstone-Porcupine Hills area (Strong, 1979). This comparison will attempt to determine what ecological conditions are associated with the areas of preferred elk use.

ECOLOGICAL SETTING

The Livingstone-Porcupine Hills area is an irregularly shaped area located approximately 65 km southwest of Calgary, Alberta (Figure 1). The eastern boundary corresponds to the eastern limits for the Resource Management Zones of the Eastern Slopes (Eastern Slopes Interdepartmental Planning Committee 1977). The British Columbia border forms the western boundary. The north and south boundaries correspond to adjoining ecological land surveys (Anderson, 1978; 1979). In total, the Livingstone-Porcupine Hills area composes 4300 km^2.

The topography is steep and broken throughout the majority of the area. The lowest elevations are located in the Cowley area. Northward from Cowley, the landscape is dominated by the Porcupine Hills which are characterized by steep, rounded slopes with relief ranging up to 370 m/km. West of the Porcupine Hills the topography has greater relief with greatest relief occurring along the Continental Divide (eg 620 m/km) and the Livingstone Range (eg 440 m/km).

Five ecoregions occur in the Livingstone-Porcupine Hills area: 1) Fescue Grassland, 2) Aspen Parkland, 3) Montane, 4) Subalpine, and 5) Alpine. The Fescue Grassland is an expanse of rough fescue (Festuca scabrella) and Parry oatgrass (Danthonia parryi) (Moss and Campbell, 1947; Moss, 1955). Approximately 12% of the Livingstone-Porcupine Hills area is composed of this vegetation cover.

The Aspen Parkland Ecoregion is a transition zone between forest and grassland vegetation. Aspen clones occur where moisture is adequate to sustain tree growth. Such sites are north facing slopes, seepage areas, and creek banks.

1 The content and points of view expressed within this paper may not reflect the policies or opinions of Alberta Energy and Natural Resources.

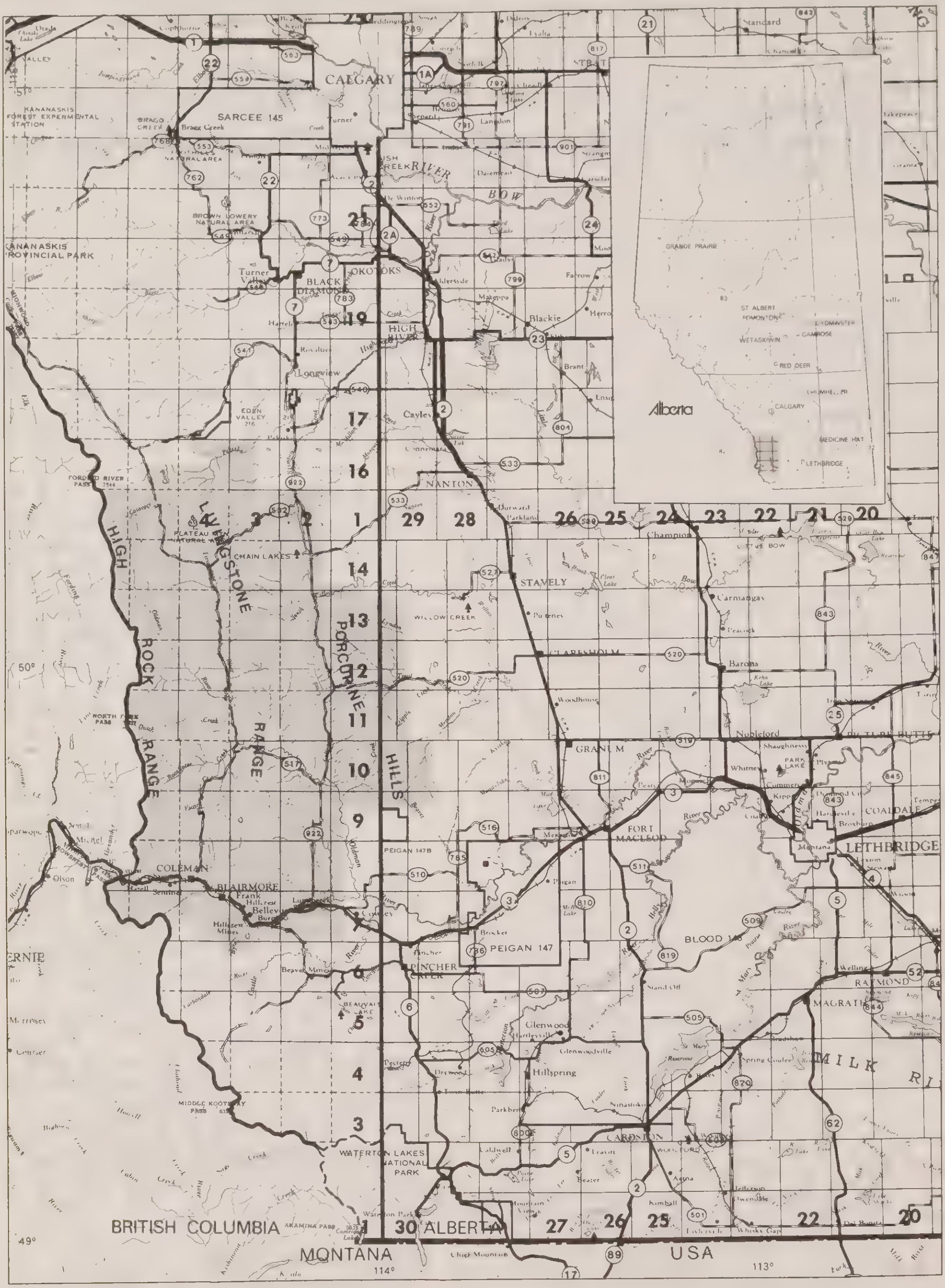


Figure 1: Livingstone-Porcupine area (scale-1:1,013,760)

Rough fescue and Parry oatgrass dominate the drier areas. Willows (Salix spp.), saskatoon (Amelanchier ainifolia), wild roses (Rosa spp.), and snowberry (Symphoricarpos spp.) are common shrubs throughout the area. Approximately 17% of the Livingstone-Porcupine Hills is vegetated by Parkland vegetation.

On a provincial scale, Montane forests are restricted to the foothills and lower valleys of southwestern Alberta. These forests are more extensive in the Livingstone-Porcupine Hills area than in any other locality in Alberta. Montane vegetation is characterized by the occurrence of Douglas fir (Pseudotsuga menziesii). Approximately 17% of the study area is composed of this ecoregion.

The Subalpine Ecoregion is a coniferous dominant zone that occurs above 1520 m in elevation. Lodgepole pine (Pinus contorta) and Engelmann spruce (Picea engelmannii) are the dominant arboreal species. The Subalpine Ecoregion occupies the largest area in the Livingstone-Porcupine Hills area, approximately 50%.

The Alpine Ecoregion occurs above climatic timber line which occurs at approximately 2135 m elevation. The Alpine zone is limited in areal extent, less than 5%, and is highly variable in its vegetation cover. This variation ranges from lush grassland to barren limestone rock.

The study identified several types of surficial deposits which formed various ecodistricts. Amongst these were lacustrine, moraine, residual, glacio-fluvial, colluvium, and rock deposits. Both ecodistricts and ecosections are too numerous to discuss here; however, these details can be obtained by consulting the ecological survey that this work uses as a basis (Strong, 1979). Table 1 represents a partial summary of the various environmental conditions, areal extent, and total number of elk observed over the five years of winter surveys.

The study area comprises some of the most productive big game habitats in Alberta. Elk, mule deer (Odocoileus hemionus), moose (Alces alces), and bighorn sheep (Ovis canadensis) are some of the more common species. The elk population consists of two distinct segments. The Bob's Creek, or A-7 herd numbering approximately 850 head is migratory, wintering on the Whaleback Ridge and migrating westward to the high country during summer. An additional 150 animals winter in various locations west of the Livingstone Range.

The Porcupine Hills elk are thought to be permenent residents of the Hills. The majority of the 650 elk winter in the Lyndon and Trout Creek area in the northern portions of the Hills.

METHODS

Ecological Land Classification

The main emphasis of ecological analysis is to divide and classify the land surface into areas of similar environment. However, one should recognize that variations occur within any designated area, but since ecological analysis is not a detailed procedure, variations should be expected. It is important that areas be sufficiently "similar", at the chosen scale, to allow evaluation of their capability.

The main tool used to derive the ecological units is air-photo interpretation which enables large study areas to be covered reasonably quickly. In general, the land surface is segmented by interpreting such factors as slope, landform, drainage, parent material, and vegetation. After completion of the initial interpretation, field checks are carried out to verify the accuracy of the outlined ecological units and to compile soil, vegetation, and other pertinent information.

The classification of the landscape begins with an understanding of the study area's physical characteristics. This study used a three tier hierarchical system of classification (Subcommittee on Biophysical Land Classification, 1969). The following is the hierarchical system:

1. Ecoregion (Land Region)
2. Ecodistrict (Land District)
3. Ecosection (Land System)

Ecoregion - The classification of the study area began with a climatic division. Herein an ecoregion is defined as "an area characterized by a distinctive regional climate as expressed by vegetation" (Subcommittee on Biophysical Land Classification, 1969). An ecoregion is usually of large extent, and can be conveniently mapped at a scale of 1:1,000,000 (1 cm to 10 km) to 1:3,000,000 (1 cm to 30 km). The heterogeneity of vegetation and physiography are implicit.

Ecodistrict - The ecodistrict is a subdivision of the ecoregion based upon distinct physiographic and/or geologic pattern. The major requirements of this subdivision are areas which have similar patterns of relief, geology, geomorphology, and genesis of parent material. In this study moraine, rock, residual, lacus-

Table 1: Characteristics of ecosections and numbers of individual animals.

	Land Classification	Area (km^2)	No. Elk Observed (1974-79)	Highest Density Elk/km^2	Vegetation	Drainage Conditions *	Percent Slope	Soil Great Group **
3	*FESCUE GRASSLAND ECOREGION*	505	467					
3M	Moraine Ecodistrict	269	467					
3M2	Ecosection	98	393	4.01	Fescue Grassland	Moderate	15-30	Black Chernozem
3M4	Ecosection	17	22	1.29	Fescue Grassland	Moderate	9-15	Black Chernozem
3M5	Ecosection	30	52	1.73	Fescue Grassland	Moderate	15-30	Black Chernozem
4	*ASPEN PARKLAND ECOREGION*	715	1257					
4M	Moraine Ecodistrict	399	1257					
4M1	Ecosection	120	252	1.36	Fescue, Aspen	Moderate	9-30	Black Chernozem
4M2	Ecosection	128	414	1.09	Aspen	Moderate	9-30	Eutric Brunisol
4M3	Ecosection	60	546	3.72	Fescue, Aspen	Moderate	9-15	Black Chernozem
4M4	Ecosection	77	45	0.38	Aspen	Moderate	5-30	Eutric Brunisol
5	*MONTANE ECOREGION*	715	3829					
5M	Moraine Ecodistrict	300	376					
5M1	Ecosection	51	154	1.85	Fescue, Douglas Fir	Moderate-Well	15-30	Black Chernozem
5M2	Ecosection	94	176	0.93	Mixed Conifers	Moderate	15-30	Eutric Brunisol
5M4	Ecosection	141	2	0.01	Aspen, Douglas Fir	Moderate	9-30	Eutric Brunisol
5M5	Ecosection	9	44	4.89	Douglas Fir	Moderate	30-60	Eutric Brunisol
5MR	Moraine-Rock Ecodistrict	287	3444					
5MR1	Ecosection	86	107	0.92	Fescue, Limber Pine	Well-Moderate	46-60	Black Chernozem
5MR2	Ecosection	133	240	0.94	Aspen, Douglas Fir, Pine, Fescue	Moderate	15-30	Black Chernozem, Eutric Brunisol
5MR3	Ecosection	68	3097	9.90	Fescue, Douglas Fir	Moderate	15-45	Black Chernozem, Eutric Brunisol
5X	Residual Ecodistrict	60	9					
5X2	Ecosection	17	9	0.53	Lodgepole Pine	Moderate	15-30	Eutric Brunisol
6	*SUBALPINE ECOREGION*	2177	463					
6M	Moraine Ecodistrict	870	91					
6M2	Ecosection	244	91	0.31	Lodgepole Pine	Moderate	5-30	Eutric Brunisol
6X	Residual Ecodistrict	810	370					
6X1	Ecosection	437	173	0.81	Lodgepole Pine	Moderate	15-45	Eutric Brunisol
6X3	Ecosection	231	20	0.09	Spruce-fir	Moderate	15-60	Eutric Brunisol
6X6	Ecosection	73	177	1.25	Grassland	Moderate	30-45	Dark Brown Chernozem
6RX	Rock-Residual Ecodistrict	111	2					
6RX1	Ecosection	111	2	0.02	Sparse and Variable	Well	+60	Regosol, Brunisol

* Canada Department Agriculture (1974)

** Canada Soil Survey Committee (1978)

trine, glacio-fluvial, and fluvial deposits were recognized.

Ecosection - An ecodistrict is further subdivided into ecosections within which there are recurring patterns of slope, landform, soils, and vegetation. Ecosections are mapped at a scale of 1:100,000 (1 cm to 1 km) and form the basic units of evaluation.

Wildlife Inventory

Animal distributions were obtained from aerial surveys conducted by the Fish and Wildlife Division (Cook and Hall, 1974; Froggatt, 1978; Froggatt and Hall, 1976; Froggatt et al, 1975; Gudmundson, 1977; and Vriend and Clark, 1975). Further distributional data were obtained from surveys carried out by Beak Consultants (Larsen, 1975). All surveys were flown during the winter months with either fixed wing aircraft or helicopters. Surveys were designed to completely cover all winter ranges and, therefore, the majority of the animals were observed.

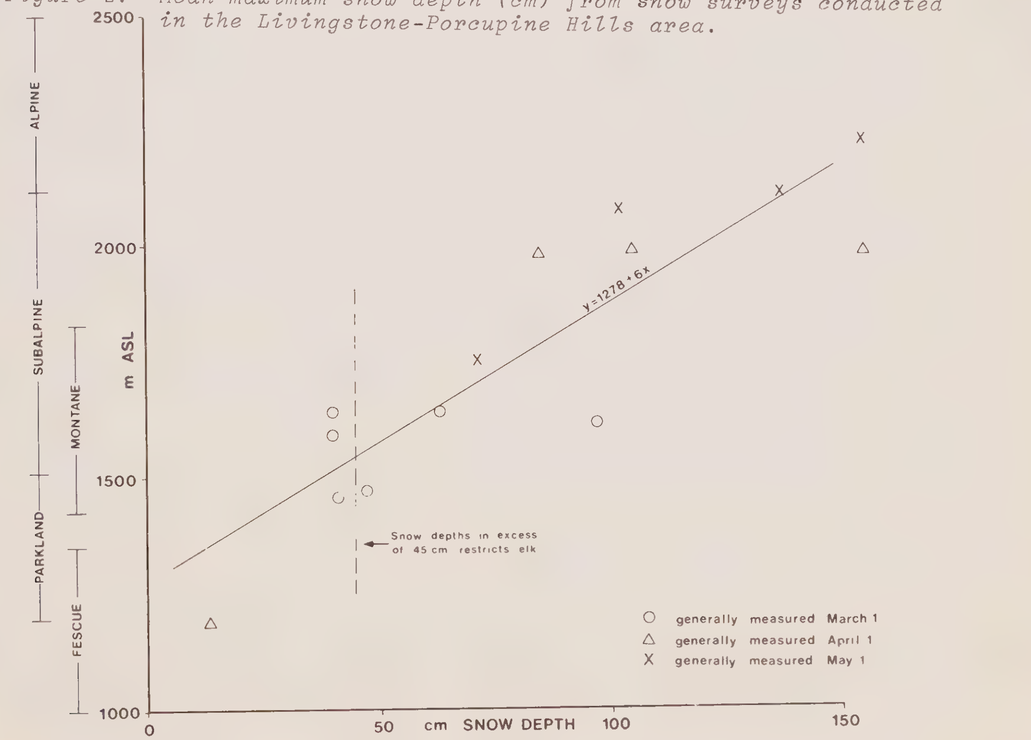
RESULTS

Elk were observed in four ecoregions at the time of the winter surveys. Of the eight ecodistricts within these ecoregions, five had substantially more elk than the others. Moraine (M) and moraine-rock (MR) composed the dominant surficial deposits of these ecodistricts. These deposits were strongly to very steeply (10-45%) sloping upland areas.

Elk were observed on eighteen ecosections and ten of these had densities in excess of one elk/km^2. Four of these had densities in excess of three elk/km^2 (Table 1). These were 3M2 - 4.01 elk/km^2, 4M3 - 3.72 elk/km^2, 5M5 - 4.89 elk/km^2, and 5MR3 - 9.90 elk/km^2. Seven of the ten ecosections were areas of southern exposure and were vegetated by more than one physiognomic type of vegetation (3M2, 3M4, 3M5, 4M1, 4M3, 5M1, and 5MR3). Ecosection 6X6 forms grassland areas with southerly aspects in the Subalpine Ecoregion. The remaining two (4M2 and 5M5) were not necessarily south facing and were dominated by an arboreal cover; however, these ecosections were usually associated with the preceding ecosections if they were utilized by elk.

Snow depth and wind are the primary weather factors which affect ungulate distribution and abundance during the winter (Formozov, 1946). Snow depth influences the distribution of all big game species and forces the species to select areas of reduced snow cover. Snow depth

Figure 2: Mean maximum snow depth (cm) from snow surveys conducted in the Livingstone-Porcupine Hills area.



data for various ecoregions of the Livingstone-Porcupine Hills area are summarized in Figure 2. These measurements are taken near the time of maximum snow cover (Inland Waters Directorate 1976). It is apparent from Figure 2 that the Alpine and Subalpine ecoregions have mean snow depths in excess of 45 cm in late winter and early spring. In the Highwood Summit and Wilkinson Summit area, "bush" has a snow depth 15-25% greater than "clear" areas.

Although snowfall is generally accompanied by light winds in southwestern Alberta, strong winds play a prominent role in its removal after it has fallen. Winds at Cowley (Figure 1) are west to southwesterly 40% of the year, with a maximum of 50% during December (Atmospheric Environment Service 1975). These westerly to southwesterly winds have a mean wind speed of about 30 km/hr which is much higher than any of the other direction. These strong winds are important in physical removal, sublimation, and evaporation of snow cover from slopes with westerly to southwesterly aspects. Days with these strong winds and a maximum temperature above $4^{o}C$ are defined as chinook days. These conditions prevail on 25 to 30 days from December to February in the Montane Ecoregion.

Table 2 represents the mean monthly temperatures for the various ecoregions in the Livingstone-Porcupine Hills area. It is apparent that the Fescue Grassland and the Montane Ecoregions have the warmest mean annual temperatures. Mild winters typify the Montane Ecoregion as indicated by the warm mean December to March temperatures (Table 2). Table 1 shows that elk have a high frequency of occurrence in this ecoregion during the winter months.

CONCLUSIONS

Several conclusions can be drawn from the comparison of elk distribution data and ecological land classification hierarchy from the Livingstone-Porcupine Hills area. Elk are primarily grazers during the winter months. Mackie (1970) stated that "Foraging on grasses normally was lowest during summer and increased sharply in early fall when grass become the predominant food, then gradually through late fall and early winter to the yearly maximum in February through mid April . . . ". Knight (1970) and Buechner and Swanson (1955) confirm the heavy winter use of grasses and suggested that fescues and wheatgrasses were preferred species. All elk in our study were observed on or near ecosections in which fescue grasslands occurred.

Snow depths also play a prominent role in elk distribution. Snow depths in excess of 45 cm forced elk to move to areas of shallower snow (Leege and Hickey, 1977). The Alpine and Subalpine Ecoregions had snow depths in excess of 45 cm and very few elk were observed within these areas. The grassland areas untilized by elk in the Montane, Aspen Parkland, and Fescue Grassland Ecoregions were all areas of lower snow accumulation. The southerly exposures ensured that maximum benefits were derived from chinook and W to SW winds in the removal of snow. Complete snow cover on these areas rarely last more than two weeks. The only ecosection within the Subalpine with a density greater than one elk/ km^2 was 6X6 which is also a grassland with a southern exposure.

Mackie (1970) noted that 42% of all elk in his study occurred on slopes steeper than 10%.

Table 2: Mean monthly temperatures (^{o}C) for the Livingstone-Porcupine Hills area.

	Mean Monthly Temperature												
Ecoregion	J	F	M	A	M	J	J	A	S	O	N	D	Mean Annual
Fescue Grassland	-10	-7	-4	3	8	12	15	14	10	5	-2	-6	3
Aspen Parkland	-10	-7	-5	-1	7	10	14	12	9	4	-3	-7	2
Montane	-8	-6	-3	2	7	11	15	14	9	5	-2	-6	3
Subalpine	-11	-9	-6	1	6	9	13	12	7	3	-3	-8	1
Alpine	-15	-15	-13	-6	2	6	10	6	5	-4	-11	-13	-4

Source: Atmospheric Environment Service 1973; Woods 1977; Harris, S. and R. Brown, unpublished.

Approximately 70 to 75% of observed elk in our study were associated with southerly exposures in the moraine and moraine-rock topography with slopes ranging between 10 and 45%. The abundance and availability of preferred winter forage as a result of the snow removal action of chinooks and W to SW winds are primary factors for their presence; however, increased solar radiation may also play a role in enhancing these sites for the species. Southerly aspects of 15 to 30% in the Livingstone-Porcupine Hills receive as much solar radiation as a nearly level (0-5% slope) area of 40° latitude (Buffo et al 1972). This increased level of radiation would aid in snow removal through an increase in daily maximum temperatures.

Aerial surveys, from which elk observations were derived, were conducted during the late winter months (February or March) and were only flown after a heavy snowfall and prior to strong winds. Elk in conditions such as this normally frequent the exposed slopes and were readily observed. Some of the animals were observed in heavier cover (eg 4M2, 5M2). Cover types such as this in conjunction with exposed slopes are important as hiding and thermal cover for elk and are heavily used during periods of inclement weather. Black et al (1975) described a mix of 40% cover to 60% forage area as optimum habitat for elk; however, it is difficult to assign cover requirements to a specific winter range since so many variables exist between areas. In this region we can assume 5MR3 Ecosections to be optimum. On this ecosection, forage area constitutes 60 to 75% of the area and thermal and hiding cover the remainder. In other frequented ecosections, the ratios between forage and cover were more biased and resulted in elk utilizing several adjoining ecosections to supply their habitat requirements.

In summary, Ecosection 5MR3 and some ecosections in combination (3M2, 4M1, 4M2, 5M1, and 5M2), had the highest concentrations of elk during the winter. These areas approximated the vegetation characteristics described by Black et al (1975) as optimal habitat in terms of forage/cover ratios.

An ecological land classification can accommodate wildlife data after the initial classification has been developed. The use of this hierarchical data by wildlife biologists would appear to be a valuable tool, although the survey team must be aware of the type of data (vegetation, climate, topography) desired by these resource managers. The resource manager can use the hierarchical data in two ways: firstly, to determine which ecosystems are favored by the wildlife species; and, secondly, to determine which ecological characteristics are associated with those ecosystems. Insight into these two factors may assist the biologist in managing the wildlife resource.

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CLÉ D'ÉVALUATION DU POTENTIEL DU TERRITOIRE DE LA BAIE JAMES POUR L'ORIGINAL

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RÉSUMÉ

Dans le cadre de l'entente entre la Société de Développement de la Baie James et le Ministére du Tourisme, de la Chasse et de la Pêche pour faire une étude sur l'orignal à baie James, des inventaires de populations one été menés pendant deux années consécutives (1974 et 1975) dans le but de déterminer la densité et la distribution de l'orignal à baie James, de même que le degré d'utilisation des différents habitats du territoire. A partir de ces résultats et des données recueillies par le cartographie écologique de territoire de la baie James, nour avons réalisé une clé permettant d'évaluer le potentiel pour l'orignal des unités de la carte écologique.

En vertu des hypothéses posées, la potentielle de l'orignal à la baie James a été reliée directement à la production potentielle de végétation feuillue sous toutes ses forms disponisbles. Le <u>Type Ecologique</u> s'est révélé être le niveau de perception idéal pour estimer l'aptitude du sol à fournir la végétation considérée. La fréquence d'apparition des feuillus sur chaque type écologique a été calculée puis corrigée en fonction de l'effort d'échantillonnage. Tous les types écologiques ont été hiérarchisés selon leur valeur de fréquence corrigée et répartis en trois classes de potentiel. Cependant, diverses contraintes opérationnelles nous one obligés à insérer notre évaluation des types écologiques dans le cadre du <u>Systéme Ecologique</u>. Le potentiel des systémes écologiques est déterminé finalement par le rendement en feuillus des types écologiques qui les composent.

ABSTRACT

As part of the agreement between the James Bay Development Corporation and the Quebec Department of Tourism, Fish and Game on the study of moose and James Bay, population surveys were carried out during two consecutive years (1974 and 1975) to determine the density and distribution of the moose population at James Bay, as well as the degree of use of the various habitats in the area. Based on these results and the data collected by SEER,[1] which is responsible for the land classification and ecological mapping of the James Bay area, we developed a key to estimate the moose potential of ecological mapping units.

Under the hypotheses presented, the potential moose production at James Bay was directly related to the potential production of deciduous vegetation in all available forms. The ideal perception level for estimating the ability of the soil to supply the vegetation in question proved to be the <u>Ecological Type</u>. The appearance frequency of hardwoods on each ecological type was calculated and subsequently corrected in accordance with the sampling effort. All ecological types were ranked according to their corrected frequency values and divided into three potential classes. Various operational constraints, however, forced us to adapt our assessment of ecological types into the context of the <u>Ecological System</u>. The potential of ecological systems is finally determined by the hardwood yield of their constituent ecological types.

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1 Service des Etudes Ecologiques Régionales (Environnement Canada).

INTRODUCTION

Depuis le début de l'entente entre la Société de Développement de la Baie James et le Ministère du Tourisme, de la Chasse et de la Pêche pour l'étude des ongulés de la baie James, les travaux de recherche sur l'orignal (Alces alces) ont été surtout orientés vers des inventaires de populations par voie aérienne (Grenier, 1974; Morasse, 1975). Ces inventaires ont permis d'évaluer la densité et la distribution de l'orignal, de même que le degré d'utilisation des différents habitats du territoire (Grenier et Audet, 1974; 1976; Grenier, 1975; Audet, 1976). Les nombreuses observations recueillies au cours de ces deux années d'inventaire, ainsi que l'avancement actuel des travaux de l'équipe du SEER chargé de la classification et de la cartographie écologique du territoire, rendent possible aujourd'hui la réalisation d'une clé d'évaluation du potentiel du territoire de la baie James pour l'orignal. Le présent document expose les hypothèses de base, ainsi que tous les renseignements nécessaires à la compréhension et à l'application de cette clé de potentiel.

OBJECTIF

La gestion rationnelle des ressources nécessite une connaissance de leur potentiel afin d'orienter les efforts et les investissements là où celui-ci est le plus élevé (Jurdant et al, 1977).

Dans cette optique, notre participation au niveau de l'évaluation des possibilités naturelles qu'offre le territoire de la baie James dans le domaine de la faune ongulée et, plus particulièrement de l'orignal, constitue un outil additionnel pour qui veut faire une juste exploitation des ressources naturelles du territoire de la baie James.

GÉNÉRALITÉS

Notion de potentiel

Pour éviter toute ambiquîté inhérente à l'utilisation du mot "potentiel", nous présentons à ce paragraphe la définition et les quelques notions de "potentiel" qui ont servi à l'élaboration de ce travail. Il faudra donc retenir que:

1) L'évaluation du potentiel du territoire de la baie James pour l'orignal se résume à l'évaluation de l'aptitude naturelle du sol à produire une végétation utile à l'orignal (nourriture et abri) au cours des étapes de la succession végétale.

2) Les classes de potentiel assignées à l'unité de base retenue pour la classification sont obtenues à partir des propriétés intrinsèques les plus stables et les plus permanentes de cette unité, telles qu'elles ont été observées au cours de l'inventaire écologique.

3) Les classes de potentiel ne tiennent pas compte de l'accessibilité de l'unité, de son état actuel ni des méthodes de sylviculture et d'aménagement forestier qu'on a pu ou que l'on pourrait pratiquer pour augmenter la capacité productrice des unités (Ex: scarification, fertilisation, ensemencement).

4) Nous avons considéré les cas de régénération après coupe totale ou partielle au niveau des compilations parce que ces activités, selon nous, n'ont fait aucunement appel aux méthodes de sylviculture citées plus haut et que, par conséquent, la végétation qui apparaît sur ces terrains exprime le potentiel du sol au même titre que toute autre perturbation naturelle.

Niveaux de perception utilisés

Afin de rencontrer notre objectif, nous avons travaillé au niveau du Type Écologique. Défini comme une combinaison relativement uniforme du sol et de la chronoséquence végétale (Jurdant et al, 1977), le type écologique s'est révélé être le niveau de perception idéal pour estimer l'aptitude du sol à produire une végétation utile à l'orignal. Cependant, diverses contraintes cartographiques nous ont obligés à insérer notre évaluation des types écologiques dans le cadre du Système Écologique. Pour plus de facilités, la clé d'évaluation du potentiel du territoire de la baie James pour l'orignal sera donc bâtie pour être utilisée au niveau du système écologique.

Hypothèses de base

Les résultats des travaux de Grenier et Audet (1976), ainsi que les nombreuses observations effectuées au cours des inventaires laissent croire que l'orignal à la baie James s'accommode des différents habitats qui se présentent dans chaque secteur et qu'il utilise en définitive, pour son alimentation, toutes les formes de végétation feuillue disponible. La constatation de cette grande faculté d'adaptation chez l'orignal nous amène à formuler notre principale hypothèse de travail:

Hypothèse 1: Toute essence feuillue disponible à l'état arbustif de façon

permanente ou temporaire peut entrer dans la composition de la diète de l'orignal. La disponibilité de cette végétation feuillue est, par conséquent, le principal facteur qui limite la distribution et la densité de l'orignal sur le territoire de la baie James.

D'autres observations font ressortir que l'orignal à la baie James semble peu importuné par l'épaisseur de neige au sol. La présence de certains animaux dans des endroits ouverts, les importants déplacements de quelques individus le long des cours d'eau ou dans les tourbières remettent en cause l'importance du couvert résineux pour les déplacements et, par conséquent, la notion même de "ravage".

De façon générale, nous croyons que la différence dans les précipitations nivales entre la baie James et le sud de la province peut être assez importante pour permettre aux animaux une plus grande mobilité et que cette mobilité peut être aussi fonction de la qualité et de la quantité de nourriture disponible à l'intérieur du domaine vital. Notre deuxième hypothèse de travail se présente donc ainsi:

Hypothèse 2: La neige n'est pas un obstacle important pour l'orignal à la baie James et la présence d'un bon couvert de résineux n'est pas jugée essentielle pour l'habitat d'hiver.

EVALUATION DU POTENTIEL DE L'ORIGNAL AU NIVEAU DE PERCEPTION DU TYPE ÉCOLOGIQUE

Selon notre première hypothèse, la production potentielle de l'orignal sur le territoire de la baie James est directement reliée à la production potentielle de certains groupements de feuillus. A partir des données recueillies par le SEER lors de l'inventaire écologique du territoire, nous avons pu établir certaines relations préliminaires sol-végétation, qui nous ont permis d'évaluer, en première approximation, l'aptitude du sol à fournir la végétation qui nous intéresse.

MÉTHODES

Traitement des données de végétation

a) Classification par type écologique

La méthode d'inventaire utilisée par SEER consiste à faire un transfert de quelques kilomètres, la Reconnaissance Écologique, au long duquel sont répartis des points d'observation et des stations écologiques de référence dans les milieux les plus représentatifs. A chacun de ces arrêts, les membres du SEER effectuent tous les relevés de végétation et de sol nécessaires à la définition d'un Type Physionomique de Végétation (Jurdant et al, 1977) et d'un type écologique.

A partir de l'information recueillie sur le terrain par le SEER, nous avons regroupé tous les types physionomiques de végétation observés sur chaque type écologique du territoire. Plus de 7 000 types physionomiques de végétation ont ainsi été classés parmi les 158 types écologiques provisoires sur lesquels ils avaient été observés. Cette façon de procéder nous a permis de dresser la liste des différents stades végétaux pouvant apparaître sur un même type écologique.

b) Classification par région écologique

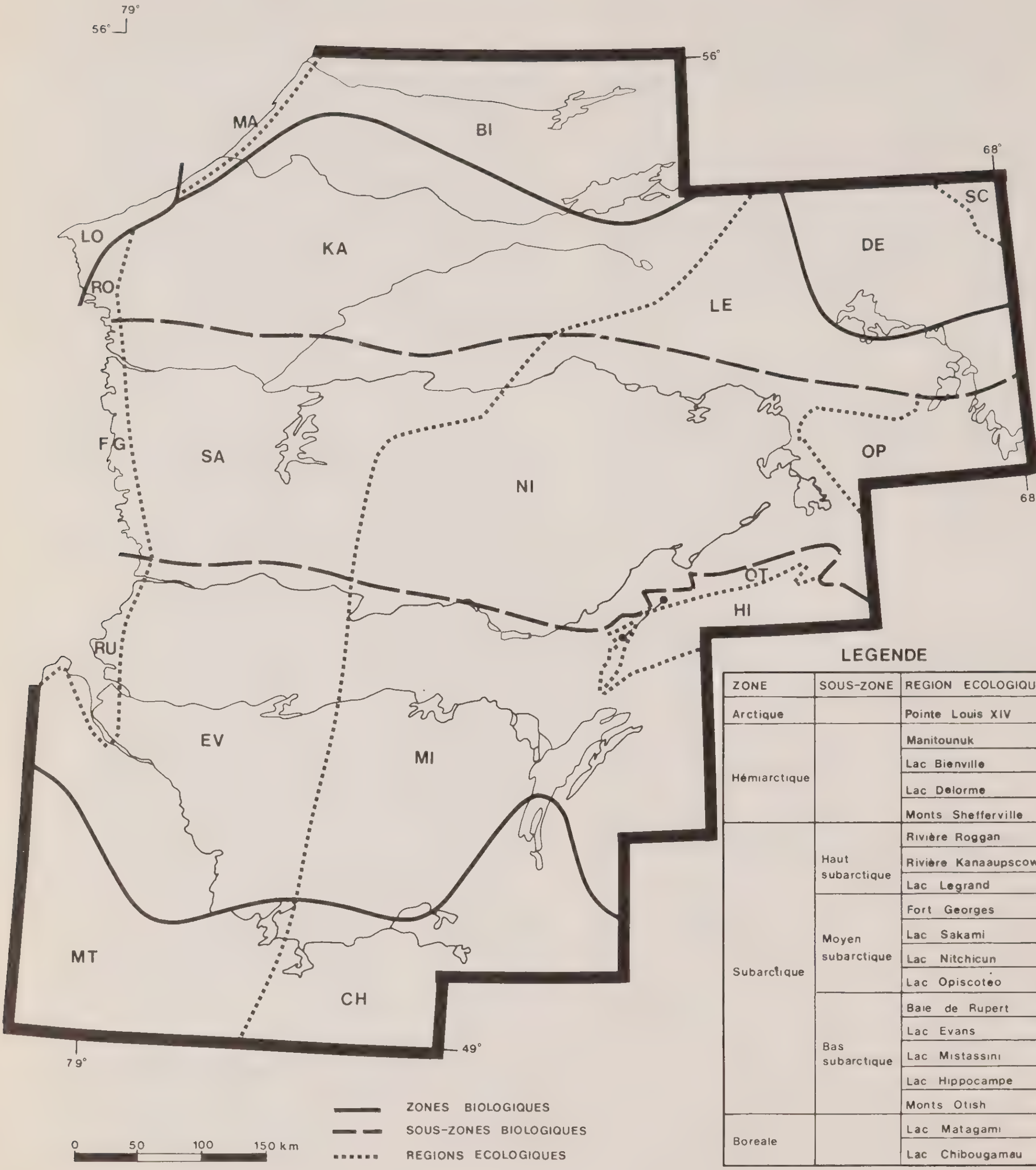
Sur un territoire aussi vaste que celui de la baie James, il est normal que des portions de ce territoire subissent des influences climatiques différentes et que celles-ci s'expriment entre autres par la végétation. La définition de ces Régions Écologiques (Ducruc et al, 1977) nous permet de considérer la végétation à l'intérieur d'un même cadre écoclimatique et d'obtenir ainsi une précision accrue sur son évolution. Parvenus à ce stade, nous retrouverons, sur un même type écologique, des chronoméquences identiques.

La dernière étape du traitement des données de végétation consiste à répartir tous les types physionomiques de végétation rencontrés sur un même type écologique dans chacune des régions écologiques où ils ont été observés.

c) Regroupement des régions écologiques

Etant donné le peu d'informations que nous possédons sur les habitudes alimentaires régionales de l'orignal à la baie James, nous avons jugé inutile de traiter la végétation par région écologique. Nous avons opté plutôt pour un regroupement de régions écologiques en fonction des importantes coupures observées dans le couvert végétal, tel que proposé par Ducruc et al, (1977). Ainsi, pour notre travail, le territoire de la baie James sera divisé en quatre zones écologiques: la zone boréale, subarctique, hémiarctique et arctique (Figure 1).

Zone boréale: Située grossièrement entre le 49° et le 52°30' de latitude nord, cette zone correspond au domaine des forêts claires caractérisées par des forêts dont le recouvrement arboré varie de 40 à 80% et la



LEGENDE

ZONE	SOUS-ZONE	REGION ECOLOGIQUE	
Arctique		Pointe Louis XIV	LO
Hémiarctique		Manitounuk	MA
		Lac Bienville	BI
		Lac Delorme	DE
		Monts Shefferville	SC
Subarctique	Haut subarctique	Rivière Roggan	RO
		Rivière Kanaaupscow	KA
		Lac Legrand	LE
	Moyen subarctique	Fort Georges	FG
		Lac Sakami	SA
		Lac Nitchicun	NI
		Lac Opiscoteo	OP
	Bas subarctique	Baie de Rupert	RU
		Lac Evans	EV
		Lac Mistassini	MI
		Lac Hippocampe	HI
		Monts Otish	OT
Boreale		Lac Matagami	MT
		Lac Chibougamau	CH

Figure 1: Les régions écologiques du territoire de la Baie James.

hauteur des arbres de neuf à 21 mètres (Ducruc et al., 1977).

Zone subarctique: Cette deuxième division, dont la limite septentrionale s'étend approximativement jusqu'au 55o30' N, englobe respectivement le domaine des forêts très ouvertes et le domaine des landes boisées et se distingue de la zone boréale par une plus grande ouverture du couvert forestier (5 à 40%) et par une diminution de la hauteur des arbres (15 mètres).

Zone hémiarctique: Cette zone occupe la partie la plus septentrionale du territoire de la baie James, des confins de la zone subarctique jusqu'au 56o N. C'est le domaine de la lande à lichens où l'on remarque entre autre l'abondance locale de certains arbustes comme Betula glandulosa, Alnus crispa et Salix spp.

La zone arctique correspondant à la région écologique de la Pointe Louis XIV (Ducruc et al, 1977) a été ignorée dans ce travail parce que nous croyons que les landes arctiques, qui composent le couvert végétal de cette région écologique, ne sauraient subvenir aux besoins alimentaires de l'orignal.

Evaluation de la production potentielle de feuillus

a) Classification des feuillus(1)

Dans le processus d'évaluation de l'aptitude de chaque type écologique à produire une végétation utile à l'orignal, nous proposons de classer cette végétation en quatre catégories selon les possibilités du système de classificaton de la végétation utilisée par le SEER (Jurdant et al, 1977).

1) Peuplements feuillus: peuplements dont 75% et plus de la surface terrière est occupée par des feuillus tolérants et/ou intolérants, à différents stades de leur évolution.

2) Peuplements mélangés: peuplements dont 25% et plus de la surface terrière est occupée par des feuillus tolérants et/ ou intolérants, à différents stades de leur évolution.

3) Arbustaie supérieure: sont considérés dans cette classe les groupements d'arbustes tels que aulnaies, saulaies et les arbustaies à bouleaux gladuleux, pures ou mixtes.

4) Arbustaie inférieure: tous les arbustes que l'on trouve au niveau de la strate inférieure de tous les peuplements autres que ceux mentionnés ci-haut et identifiés dans le type physionomique de la végétation (Jurdant et al, 1977).

b) Calcul de la fréquence d'apparition des feuillus

Pour le traitement intra-zonal des données de végétation, nous avons réuni toutes les reconnaissances écologiques et nous avons procédé par la suite de la même façon qu'au paragraphe 'Classification par type écologique'.

Pour les zones boréale et subarctique, les types écologiques avec 20 relevés et plus ont été retenus en vue du calcul de fréquences. Pour la zone hémiarctique, cette limite arbitraire a dû être abaissée à la fréquence absolue de cinq relevés à cause du faible nombre d'observations effectuées sur chaque type écologique de cette zone.

La fréquence d'apparition des feuillus sur chacun des types écologiques de chaque zone a été, dans un premier temps, calculée puis corrigée en fonction de l'effort d'échantillonnage selon la formule du profil de fréquences corrigées (Gerardin, 1977).

$$Fc = \frac{P_i}{R_i} \bullet \frac{RT}{PT_K}$$

Fc - fréquences corrigées
RT - total des relevés effectués dans une zone
PT_K - total des présences de feuillus observées dans une zone
P_i - total des présences de feuillus observées sur un type écologique donné dans une zone
R_i - total des relevés effectués sur ce type écologique donné dans une zone

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(1) Il est à remarquer que l'appellation du terme "feuillu" dépasse largement celle proposée par le Service de l'inventaire forestier (1971) et qu'elle s'applique aussi bien aux strates arbustives, qu'aux strates arborescentes. Le système de classification des feuillus que nous proposons dans ce travail englobe de surcroît toute végétation arbustive installée sur les terrains forestiers improductifs (tourbières, aulnaies, affleurements rocheux).

	Types écologiques				
	1	2	i	N	
Présence de feuillus	P_1	P_2	P_i	P_N	$PT_K = \sum_{i=1}^{N} P_i$
Absence de feuillus	A_1	A_2	A_i	A_N	$AT = \sum_{i=1}^{N} A_i$
Nombre total	R_1	R_2	R_i	R_N	$RT = \sum_{i=1}^{N} R_i$

Dans un deuxième temps, nous avons rendu possible la comparaison des valeurs entre zones en effectuant la pondération suivante:

1) Pour chaque zone, nous avons obtenu une valeur de PT_K qui est la somme de feuillus observés.

$$PT_K = \sum_{i=1}^{N} P_i$$

2) Pour l'ensemble du territoire, nous aurons un PTT.

$$PTT = \sum_{K=1}^{3} PT_K$$

3) Le coefficient de pondération inter-zone sera donné par la relation suivante:

Coefficient de pondération inter-zone = $\frac{PTT}{PT_K}$

4) La nouvelle fréquence pondérée se calculera ainsi:

$$Fp = Fc \bullet \frac{PTT}{PT_K}$$

Fp - fréquence pondérée

Pour faciliter la comparaison des valeurs inter-zone, nous avons, dans un dernier temps, ramené les fréquences pondérées en pourcentage en divisant d'abord chaque valeur obtenue à l'intérieur d'une zone par la fréquence pondérée la plus élevée de cette zone puis en multipliant le résultat par 100.

c) Répartition des types écologiques par classe de potentiel

Une fois hiérarchises, les types écologiques de chaque zone ont été divisés en trois classes de potentiel selon les intervalles de fréquence pondérée suivants:

Tableau 1: Intervalles de fréquence pondérée utilisés pour déterminer les classes de potentiel des types écologiques.

Classes de potentiel	Intervalles de fréquence pondérée %	Interprétation des classes de potentiel
1	25.0 à 100.0	Bon à excellent
2	10.0 à 24.9	Faible à modérément bon
3	0.0 à 9.9	Nul à très faible

Les appendices 1, 2 et 3 présentent la hiérarchisation de ces types écologiques en fonction de la valeur de leur fréquence pondérée.

Environ dix pour cent des types écologiques présentés en appendice ont subi ultérieurement un changement de classe parce que la valeur de fréquence pondérée obtenue pour chacun d'eux traduisait mal la réalité observée sur le terrain par les membres du SEER. Etant donné que l'identification des types écologiques et des types physionomiques de végétation, effectuée par le SEER lors de l'inventaire écologique, n'a pas été entièrement revue et corrigée, il est possible que des types physionomiques de végétation aient été associés à des types écologiques mal identifiés. Cette source d'erreur pourrait être à l'origine des quelques valeurs anormales que nous avons remarquées. L'appendice 4 donne la liste des types écologiques dont la classe de potentiel a été modifiée.

Finalement, les types écologiques, qui avaient été rejetés des calculs de fréquence pondérée à cause de leur faible échantillonnage, ont été évalués un à un par des membres du SEER puis répartis dans une des trois classes, en fonction de leur ressemblance avec les types écologiques déjà classés.

RÉSULTATS

Potentiel des types écologiques à produire une végétation utile à l'orignal

Le tableau 2 présente en ordre alphanumérique les types écologiques accompagnés de la classe de potentiel qui leur a été attribuée dans chaque zone.

PONDERATION AU NIVEAU DES CLASSES DE POTENTIEL DE CHACUNE DES ZONES ECOLOGIQUES

Jusqu'ici, nous nous sommes préoccupés de l'aspect présence-absence de la végétation feuillue. Les calculs de fréquence pondérée nous ont permis de classer respectivement les types écologiques dans chacune des zones selon leur aptitude à produire une végétation feuillue. Les valeurs obtenues ne nous permettent cependant pas de juger de l'importance de la phytomasse rencontrée sur un même type écologique dans chacune des zones écologiques. Ainsi, par exemple, AF3*, qui appartient à la classe 1 de potentiel dans les trois zones, n'aura pas la même capacité de support pour les orignaux dans la zone boréale que dans la zone hémiarctique. Pour contourner ce problème, nous avons dû pondérer chacune des trois classes de potentiel dans chaque zone écologique. Les densités d'orignaux trouvées par Grenier (1975) et Audet (1976) nous ont aidés à établir les valeurs de pondération. La densité d'orignaux passant du simple au double du nord au sud, nous avons accordé les valeurs maximales à la zone boréale (classe 1 3, classe 2 2, classe 3 1,) et nous avons multiplié ces valeurs par 0.75 pour la zone subarctique et par 0.50 pour la zone hémiarctique. Le tableau 3 attribue un coefficient de pondération à chaque classe de potentiel de chaque zone écologique.

EVALUATION DE POTENTIEL POUR L'ORIGNAL AU NIVEAU DE PERCEPTION DU SYSTEME ECOLOGIQUE

Importance accordée à chacun des descripteurs du système écologique

Les paragraphes subséquent justifient l'utilisation ou non, dans notre clé, de chacune des composantes du système écologique (Figure 2).

Région écologique

L'influence du climat régional a déjà été intégrée au niveau des compilations de végétation.

Relief

Aucun type de relief ne saurait pas lui-même exlure la présence de l'orignal d'un système écologique. Le relief agit plutôt, dans notre cas, pour déterminer la nature et l'abondance des types écologiques dans un système écologique et c'est par ce biais que son importance sera jugée.

Épaisseur des matériaux meubles et matériaux géologiques de surface

Comme dans le cas précédent, ces deux nouvelles variables écologiques ont déjà agi au niveau de la définition des types écologiques. Pour cette raison, aucune valeur ne leur sera accordée comme descripteurs du système écologique.

Catégories d'écosystème aquatique

La présence d'orignaux dans un système écologique est liée de façon stricte, toujours selon notre principale hypothèse, à la végétation disponible au cours de l'hiver. L'abondance de petits lacs ou de baies peu profondes dans un système écologique agit pour améliorer la qualité de l'habitat d'été de certains individus seulement. Le caractère accessoire de cette composante nous oblige à l'éliminer de notre processus d'évaluation du système écologique.

Tableau 2: Classes de potentiel attribuées aux types écologiques de chaque zone écologique.

Types écologiques	boréale	subarctique	hémiarctique
AA6*	*1	1	1
AF1	2	2	2
AF2	*2	*	1
AF2*	1	1	1
AF3	*2	1	1
AF3*	1	1	1
AL1	1	–	–
AL2	*1	–	–
AL2*	1	–	–
AL3	*1	–	–
AL3*	1	–	–
AL4	*1	–	–
AL4*	1	–	–
AL5	*2	–	–
AL5*	*1	–	–
AM1	2	2	2
AM23	2	2	*1
AV2*	1	1	1
AV3*	1	1	1
AV4*	*1	1	1
AV5*	1	1	*1
AV6*	*1	*1	*1
BAB6	*3	3	3
BAN6	3	3	3
BAS6	3	3	3
BN6	*3	*3	3
BNB6	*3	3	3
BNB6*	3	3	3
BPB6	3	3	3
BPN6	3	3	3
BPS6	3	3	3
BRB6	3	*3	3
BRN6	3	3	3
BRS6	3	3	3
BS6	*3	3	3
BVN6	3	3	*3
BVS6	3	3	3
CR46*	2	2	1
CV23*	*1	*1	*1
CV4*	2	1	1
DU1	3	3	3
DU2	3	3	3
ER23*	1	1	1
FAB6*	*1	1	2
FAN6*	3	3	3
PAS6*	3	3	3
PB6*	*1	*1	2
FN6*	*3	*3	*3
FPB6*	1	*1	2
FPN6*	3	3	3
FPS6*	3	3	3
FRB6*	1	1	2
FRN6*	3	3	3
FRS6*	3	3	3
FS6*	*3	*3	*3
FVB6*	*1	*1	*2
FVN6*	*3	*3	*3
FVS6*	3	*3	*3
ST25*	–	–	3
MA23	*1	*1	2
MA23*	1	1	1
MA4	*2	*2	2
MA4*	1	1	*1
MA5	2	*2	2
MA5*	1	1	1
MA7	3	3	3
PA7	3	*3	*1
PAA7	–	3	*1
PP7	–	3	1
PY5	–	3	3
PY5*	–	1	1
PY6	–	3	3
PY6*	–	1	1
RB16	3	3	*3
RO1	*3	*3	*3
ROB1	–	–	3
ROC1	–	–	3
ROU1	–	–	3
RO24*	3	2	*1
RO5*	3	3	2
RT14	*3	3	*2
SA1	3	2	2
SA2	2	2	1
SA3	2	2	1
SA3*	1	1	1
SA4	3	3	3
SA4*	2	2	3
SA5	3	3	3
SA5*	3	3	3
SE1	3	3	3
SG1	*2	*2	*3
SG23	*2	*2	*1
SG23*	1	1	1
SM1	2	2	2
SM23	*2	*2	*1
SM23*	1	1	1
SR2*	2	2	2
SR13	*3	*3	2
SR34*	2	2	1
SV4	*3	*3	*3
SV5	*3	3	*3
TA1	3	1	1
TA2	*2	*1	*1
TA2*	*1	*1	*1
TA3	*2	*2	*1
TA3*	*1	*1	*1
TA4	*3	*3	*2
TA4*	*3	*2	2
TA5	*3	*3	*3
TA5*	*3	*2	*2
TA6*	2	1	1
TC2	2	–	–
TC2*	2	–	–
TC3	*3	–	–
TC3*	2	–	–
TC4	*3	–	–
TC4*	2	–	–
TC5	*3	–	–
TC5	*3	–	–
TC5*	2	–	–
TD1	3	1	1
TD2	*2	*1	*1
TD2*	1	1	1
TD3	*2	*1	1
TD3*	1	1	1
TH1	3	*3	*3
TH2	*3	*3	*2
TH3	*3	*2	*1
TM1	3	2	2
TM2	*2	*2	*2
TM2*	1	2	*2
TM3	*2	*2	*2
TM3*	*1	*1	*1
TM4	3	*3	*3
TM4*	2	2	*2
TM5	3	3	3
TM5*	3	3	*3
TP1	3	3	*3
TP23	3	2	*2
TP23*	2	2	*2
TP45*	*2	*1	*1
TP6*	2	1	1
TR21	*2	*2	*2
TR2*	1	2	2
TR3	2	*2	2
TR34*	2	*2	1
TR4	3	3	3
TR5	3	3	3
TR5*	3	3	3
TY1	3	2	2
TY2	*3	*2	2
TY3	*2	2	2
TV6	*3	*3	3
TV6*	3	3	3
X2	1	–	–
X2*	1	–	–
X3	1	–	–
X3*	1	–	–
216*	3	3	3

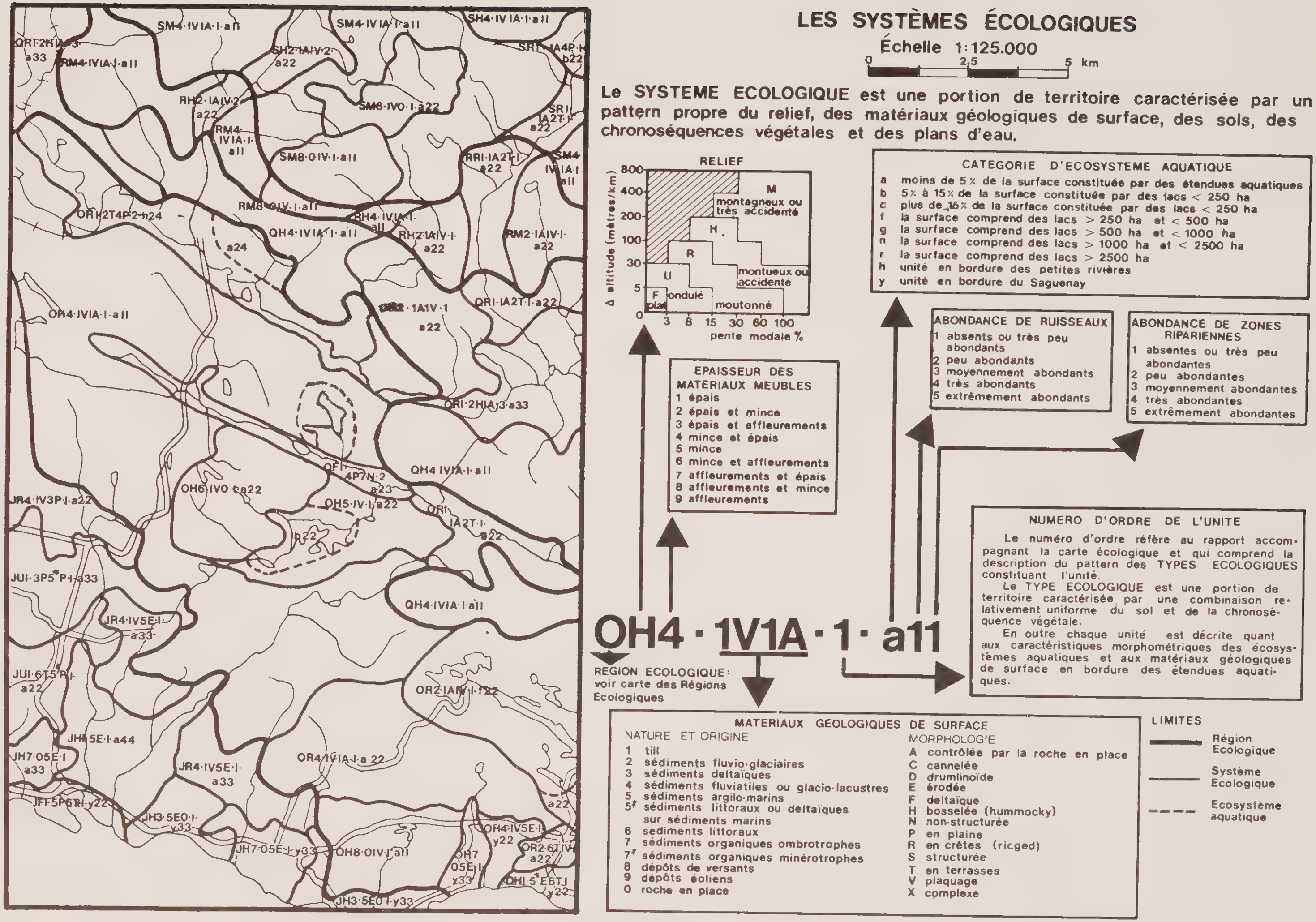

Figure 2: Légende de la carte écologique.

Abondance de ruisseaux

Ce descripteur retient notre intérêt dans la mesure ou il conditionne l'abondance des stations ripariennes (wetland). Pour éviter de nous répéter, nous évaluerons l'action des ruisseaux par le biais de l'indice d'abondance des stations ripariennes.

Abondance des stations ripariennes

Le terme "station riparienne" s'applique de façon restrictive à "l'ensemble des écosystèmes situés sur des sols périodiquement inondés, pendant un temps plus ou moins long, et colonisés par une végétation riche comprenant beaucoup d'espèces eutrophes. Cette végétation groupe entre autres les aulnaies et saulaies alluviales, mais également certaines associations végétales plus forestières telles que des pessières à aulne ou des tremblaies à aulne" (SEER, 1974). Nous comprenons rapidement l'importance de la capacité de support de ces stations ripariennes, ainsi que leur potentiel pour l'orignal. Malheureusement, "ces écosystèmes représentent de si faibles surfaces qu'ils ne figurent pas ou très peu dans les descriptions détaillées des systèmes écologiques" (SEER, 1974). C'est donc par le biais de l'indice d'abondance des stations ripariennes dans le système écologique que nous arriverons à "récupérer" ces stations et à leur accorder l'importance qu'elles méritent.

UTILISATION DE LA CLE DE POTENTIEL

Le système écologique est composé d'une portion terrestre et d'une portion aquatique. Nous avons maintenant les moyens d'évaluer chacune de ces deux parties en fonction des exigences de l'orignal.

Potentiel de la portion terrestre du système écologique

L'estimation du potentiel de la partie terrestre du système écologique se fait aisément à partir des fiches descriptives des systèmes écologiques définis dans la carte écologique du territoire de la baie James (Tableau 5). La valeur du coefficient de pondération applicable à chaque classe de potentiel de chaque zone se trouve au tableau 3.

Par exemple, pour un système écologique situé dans la zone subarctique, nous exécuterons les opérations suivantes:

[Σ Des pourcentages de types écologique de classe 1) x 2.25] +

[Σ des pourcentages de types écologiques de classe 2) x 1.5] +

[Σ des pourcentages de types écologiques de classe 3) x 0.75] =

Le nombre de points obtenus après ces calculs varie entre 50 et 300 points. Les classes de potentiel, pour la portion terrestre du système écologique, se répartissent donc ainsi:

Tableau 3: Coefficients de pondération attribués aux classes de potential dans chaque zone écologique.

Classes de potentiel	Zones écologiques		
	Boréale	Subarctique	Hémiarctique
1	3	2.25	1.50
2	2	1.50	1.00
3	1	0.75	0.50

Tableau 4: Determination de la classe de potentiel de la partie terrestre du systeme écologique d'apres le total des points obtenus.

Total des points	Classes de potentiel
217-300	1
133-216	2
50-132	3

Tableau 5: Fiche descriptive d'un système écologique: information actuellement disponible.

SYSTÈME ÉCOLOGIQUE

R: 101 — Terrestre: U1-4*T9H-1

Photo: 33G n° 105 — Aquatique: à 24-i 24 i-1111-4

Type écologique Provisoire	Type écologique Définitif	Landform	Drainage	%	Sol	Végétation
AV6*		4cv	6*	30		
AM23		$4c^1m$	23	30		
DU1		9a	1	5		
DU2		9a	2	15		
FS6*		7*S	6*	20		
TA5		$4c^1$	5	10		

Potentiel de la portion aquatique du système écologique

La portion aquatique est évaluée essentiellement a partir de l'indice d'abondance des stations ripariennes que nous présentons ci-dessous.

Tableau 6: Détermination de la classe de potentiel de la partie aquatique du système écologique d'après l'indice d'abondance des stations ripariennes.

Classes d'abondance des stations ripariennes	Classes de potentiel
1- absent ou très peu	3
2- peu	3
3- nombre moyen	2
4- beaucoup	1
5- très abondant	1

Potentiel du systeme écologique

Les classes de potentiel de la portion terrestre sont combinées avec les classes de potentiel de la portion aquatique (Tableau 7) pour donner la valeur de potentiel des systèmes écologiques.

Tableau 7: Évaluation du potentiel des systèmes écologiques pour l'orignal à la baie James.

Portion Terrestre	Portion Aquatique	Système Écologique
1	1	1
	2	2
	3	2
2	1	2
	2	3
	3	4
3	1	2
	2	4
	3	5

Cette évaluation du potentiel des systèmes écologiques accorde autant de poids à la portion terrestre du système écologique qu'à la portion aquatique. De cette façon, nous favorisons aussi bien les paysages plats et tourbeux de l'ouest du territoire, où Brassard (1972) et Morasse (1975) ont observé de fortes densités d'orignaux, que les sites bien drainés de l'est du territoire.

L'interprétation des classes de potentiel se présente ainsi:

Classes de potentiel	Interprétation des classes de potentiel
1	Très élevé
2	Elevé
3	Moyen
4	Faible
5	Très faible

AVERTISSEMENT

Nous prévoyons dans un avenir prochain être en mesure d'affiner davantage l'évaluation des types écologiques présentée dans ce travail. En effet, la définition des chronoséquences végétales nous permettra de regrouper les types écologiques qui ont un comportement semblable et de les évaluer en fonction de nouveaux critères comme, par exemple, la durée de la phase feuillue rencontrée au cours de l'évolution de la végétation.

L'utilisateur de cette clé devra être averti qu'elle ne constitue qu'une première approximation et que des changements ultérieurs surviendront au fur et à mesure que la clé sera mise à l'essai et que de nouvelles informations seront disponibles.

REMERCIEMENTS

Mes remerciements les plus sincères vont à messieurs Larry Brown, Guy Gilbert, Jean-Pierre Ducruc, Jean-Maurice Mondoux, Vincent Gerardin, Michel Jurdant du SEER et Jean-Marc Levasseur de la SDBJ, pour leur implication directe dans l'élaboration de ce travail. Merci à toute l'équipe du SEER pour la patience et l'empressement dont elle a su faire preuve à mon égard. Je ne saurais oublier Micheline Bernatchez pour la dactylographie de ce texte et Marie-Hélène Montgiraud-Roy pour sa participation efficace et détendue à l'énorme travail de compilation que nous avons partagé.

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SUMMARY OF WORKING GROUP DISCUSSIONS AND RECOMMENDATIONS

On the afternoon of the workshop's first day five working groups were formed. These groups were assigned discussion questions developed around the following topic areas:

1) *Wildlife data relevant to the goals of Ecological Land Survey (ELS);*

2) *The relationships between land ecosystems and wildlife habitat;*

3) *Methods of mapping and presenting wildlife information in ecological land surveys;*

4) *Incorporation of wildlife information other than that important for habitat identification and mapping in the ELS data base; and*

5) *The importance of wildlife terminology and definitions in the context of an ELS.*

Each group was charged with reporting through a spokesman on one of the five topic areas at the following day's plenary session Apart from the primary topic area two others were also assigned for discussion to each group so as to provide some overlap in the working groups' discussions. Not all groups found time to deal with and report on their secondary topics.

WORKING GROUP A

<u>Wayne Strong*</u> Bruce Pendergast
Ed Wiken Jack Millar
Harry Stelfox Peter Achuff
Roy Jacobson

ASSIGNED TOPICS AND QUESTIONS

<u>Primary topic area</u>: *What wildlife data are relevant to the goals of Ecological Land Survey?*

The scope and objectives of any particular ELS dictate the kinds of data gathered. Bearing this in mind we require guidelines as to what kinds of data are required to effectively integrate wildlife data into the survey. For instance:

1) What wildlife data will enable us to develop recognition criteria for the various levels of the classification system (ecoregion, ecodistrict, ecosection, etc)?

2) As well as allowing us to identify and classify land ecosystems at the various levels of generalization the wildlife data collected must also allow wildlife evaluations and interpretations to be made (ie to identify land capabilities for various wildlife uses, eg browsing, denning, breeding, migration, etc). What kinds of data fulfill this requirement?

WORKING GROUP DISCUSSION

The group concluded that it was difficult to determine how wildlife characteristics could be correlated with the various levels of the ELC hierarchy. This, in part, is because such correlations will vary with the species in question.

The ELS data base was considered suitable for wildlife evaluations but the biologist's data needs must be identified early in the project. It was felt that wildlife data should be incorporated into the ELS data base at the species level and that the species considered should be keyed to the user's interests. Furthermore, cultural data (eg land use patterns) as it affects wildlife and other patterns should also be incorporated into the data base.

RECOMMENDATIONS

1) Wildlife data should be incorporated into the ELS data base at the species level.

2) Wildlife distribution data should be coupled with the other information in the data base (soils, vegetation, landforms, climate, etc).

3) The data required by the biologist must be identified early in the ELS program.

* Underscored names denote working group chairpersons.

WORKING GROUP B

Will Holland
Richard Kerr
Bill Prescott
Dennis Demarchi
Phillip Taylor
Ian Corns
Nicholas Novakowski

ASSIGNED TOPICS AND QUESTIONS

Primary topic area: *The relationships between land ecosystems and wildlife habitat.*

Perhaps the most important link between wildlife biology and ELS is how the habitat of a species described by the wildlife biologist correlates with the land ecosystems mapped by the ELS team.

1) Based on experience to data in what ways are these two approaches compatible?

2) What input does the ELS team require from the wildlife biologist to ensure that the data which they collect and map fulfills the needs of the wildlife biologist?

   eg
   - definitions
   - habitat identification criteria
   - mapping scales
   - biophysical data required
   - biophysical data required for habitat evaluation, etc.

3) What kinds of data should the biologist practically expect the rest of the ELS team to identify and map?

4) When should the biologist join the ELS team; before and/or after the land ecosystems are mapped? Why?

WORKING GROUP DISCUSSION

Initially the group had some difficulty with the definition and acceptability of the terms habitat and land ecosystem respectively. Although these problems were not resolved a partial definition of habitat stating that an animal must or can be part of it (ie the habitat) was offered.

Wildlife habitat was considered to be a component of ecosystems compatible with soil and vegetation components of the environment. The methodologies used for studying these components was also considered compatible. On the other hand, habitats were not considered compatible with soils and vegetation in a mapping context, to the extent that, a different array of habitats is required for different kinds of wildlife.

In response to question two it was clear that the input of the wildlife biologist was required in these areas. With reference to definitions it was felt that there will be some difficulty with obtaining good, precise definitions because wildlife biologists are still learning their requirements. The term preferred habitat was considered important, but not elaborated because of the large number of variables involved. It was suggested that a diversity index might be constructed and used as an index of environmental quality. Total population estimates of wildlife species were thought to have little usefulness because of their wide temporal variations. Furthermore habitat identification criteria must also be developed before mapping can proceed.

Mapping scales were discussed ranging from the 1:24,000 used for the United States grazing lands to the 1:250,000 and for the Northern Land Use Information Series. Generally, 1:50,000 was suggested as the most desirable, in part due to its compatibility with the NTS maps. It was pointed out that mapping scale is also dependant on the type of project, user needs, and cost.

The biophysical data required for habitat evaluation include both abiotic and biotic characteristics. In the latter category the group felt that a vegetation classification plus some indication of the abundance of species important to wildlife was required. Emphasis should be placed on those factors that are presently poorly documented; for example:

- geology
- climate
- water
- snow depth
- seasonal uses
- winter range
- summer range
- preferred forage species
- plant sucession stages
- intensity of wildife use
- time of habitat assessment

The group agreed that the biologist could expect the rest of the ELS team to identify and map baseline descriptive and quantative data for landform, soil, and vegetation characteristics, and inferred climatic or zonal differences as reflected by vegetation and soil development. It was also emphasized that

the rest of the ELS team must assist the biologist in interpreting how the biophysical characteristics identified and mapped combine to provide environmental qualities affecting wildlife. For example:

- hummocky moraine versus ground moraine or lacustrine plain;

- vegetation patterns (ie size, shape, complexity), and ;

- plant succession and rates of change etc.

Furthermore, to better manage wildlife the biologist needs to know what environmental parameters can be manipulated and how. That is, what modifications can be made and what are their consequences; what requires preservation, and what management options are available.

The group felt that the biologist must join the team before mapping commences because:

- he can identify the habitats that are important for his work, including characteristics of landforms, soil, and vegetation; examples are: relief, aspect, texture, drainage, kinds of vegetation groupings, etc, and;

- early input will reduce costs by eliminating revisions and back-tracking.

RECOMMENDATIONS

It was recommended that:

1) Wildlife biologists be consulted and invited to join ELS mapping teams in the early project planning stage, and that their involvement continue throughout the active ELS classification and evaluation stages.

2) Wildlife biologists develop and provide:

   a) complete and rigorous definitions of their terminology

   b) habitat identification criteria, preferably as field guides

   c) a list of wildlife factors that are presently poorly documented but are required for improved habitat evaluation.

3) ELS team members assist wildlife biologists to interpret how environmental characteristics combine to provide environmental qualities affecting wildlife.

4) The CCELC in conjunction with specialists and all jurisdictions plan a national wildlife mapping series at 1:250,000 map scale, which would include national wildlife objectives and goals enabling acquisition of improved knowledge and thus more effective management of wildlife.

WORKING GROUP C

Don Karasiuk
Bob Hart
Herman Dirschl
Geoff Holroyd
Gerald Townsend
Brent Markham
Ian Sneddon

ASSIGNED TOPICS AND QUESTIONS

Primary topic area: *Incorporation of wildlife information other than habitat identification and mapping in ecological land surveys.*

Apart from identification, mapping and description of wildlife habitat, other important information for understanding the ecology of wildlife includes:

1) population sizes, densities, and dynamics;

2) seasonal and diurnal variation in some of the above and other factors;

3) migratory behaviour;

4) reproductive behaviour;

Much of this kind of data cannot be gathered during the relatively short time the ELS team is in the field. Clearly additional wildlife studies must be carried out.

1) How can effective integration with the rest of the information gathered by the ELS team be achieved?

2) To what extent can data from the literature be extrapolated to cover various situations?

WORKING GROUP DISCUSSION

The group disagreed with the preamble of this question because the following are objectives of wildlife inventory:

1) determining spatial distributions of species, populations and individuals;

2) determining population sizes and densities; and,

3) determining seasonal distributions of species.

However, the group agreed that population dynamics, reproductive behaviour, circadian movements and migratory behaviour are probably beyond the scope of wildlife inventory.

INTEGRATION WITH THE ELS TEAM

Effective integration with the rest of the ELS team is possible if the wildlife component agrees to adhere to the same hierarchy of land types and land systems as the soil-vegetation-landform component. However, the wildlife biologist must be an integral part of the ELS team. That is, he must have an equal voice to soils and vegetation in determining which criteria should be mapped. Criteria such as snow depth, aspect, "patchiness" of vegetation and proximity of escape terrain are very important in determining ungulate distributions, but are rarely mapped in biophysical studies. Also, biophysical studies should map actual vegetation, not potential vegetation.

All aspects of ELS studies will be more effective if the user's objectives are understood in detail. The group felt that the user should not be confused by complicated legends and a mass of technical detail. The user should be presented with thematic maps as a final report. The biologist, not the user, should do the interpretation of the survey data. Thematic maps also avoid the problem of explaining non-concordance between wildlife data and other ELS data - the "exceptional" areas are simply rated appropriately on thematic maps. Where possible, the wildlife legend should resemble that of the soils, vegetation and landforms as closely as possible.

Wildlife data should enter into the final evaluation of data and the final report. However, wildlife use per se is not a sufficient criterion for distinguishing one land type from another. Hunting, traditional patterns of wildlife use, and local extinctions preclude this.

EXTRAPOLATION OF THE LITERATURE

There are two main types of wildlife studies for the purpose of this question. The classical" study selects a small quadrat, grid or study area, and studies that intensively. Such studies often have great scientific rigor (internal validity) but we do not know how representative results are of the universe of habitats. By contrast wildlife inventory often has less detail on population function or structure, but we know how representative results are of the universe of habitats.

In many cases data from the literature cannot be extrapolated to cover large areas because:

1) The study area was atypical in having unusually high population densities or unusually large numbers of species;

2) the scientist did not describe his study area in sufficient detail;

3) the various parts of the study area were studied with varying intensities; or,

4) the species that were studied had specialized and poorly understood habitat requirements.

Ideally, wildlife inventory should precede detailed population studies. ELS inventory can aid subsequent detailed studies by:

1) determining the amount of time and money to be spent on the various habitat types. There is little value in choosing unique study areas because the results have little validity for the universe as a whole;

2) ELS studies enhance the predictiveness of "classical" studies by stating what proportion of a region the results apply to;

3) ELS studies provide a unitary package for the planner. This enables the planner to make tradeoffs among competing land uses;

4) ELS aids in the formulation of a sampling design, and aids the stratification of data in statistical analysis; and,

5) ELS permits the calculation of regional populations provided that all habitat types have been sampled.

RECOMMENDATIONS

1) The following should be considered to be essential elements of a biophysical wildlife inventory;

a) the description of wildlife distribution and numbers in geographic space;

b) the description of wildlife distribution and numbers in relation to soils, vegetation, climate and landforms; and,

c) the potential population sizes and distribution of wildlife species (capability or carrying capacity) with respect to soil, vegetation, climate and landform.

2) The workshop should recognize that the study of functional relationships among members of animal communities (competitive interactions, predator-prey relationships, mortality, natability and survivorship) are beyond the scope of biophysical wildlife inventory.

3) The wildlife biologist should have an equal voice with the other members of the ELS team in determining the criteria that are to be mapped and in determining the hierarchy of land classification.

4) The actual not potential vegetation, is a major determinant of wildlife distributions and therefore ELS teams are strongly urged to map actual vegetation.

5) The variations in wildlife distribution, numbers and land use should not be used as criteria for distinguishing one land type from another.

6) The biologist undertaking a wildlife inventory should make every effort to understand user needs, and should present his data in the form most suitable to the user. The use of themetic, single purpose maps is strongly urged.

7) Wildlife inventory, in conjunction with ELS surveys, should precede detailed functional studies (population dynamics, predator-prey studies, studies of competitive interactions etc) in the formulation of wildlife management plans.

This working group also dealt with their two secondary topic areas and assigned questions as summarized below.

Secondary topic area A: *What wildlife data are relevant to the goals of Ecological Land Survey?*

The scope and objectives of any particular ELS dictate the kinds of data gathered. Bearing this in mind we require guidelines as to what kinds of data are required to effectively integrate wildlife data into the survey. For instance:

1) What wildlife data will enable us to develop recognition criteria for the various levels of the classification system (ecoregion, ecodistrict, ecosection, etc)?

2) As well as allowing us to identify and classify land ecosystems at the various levels of generalization the wildlife data collected must also allow wildlife evaluations and interpertations to be made (ie to identify land capabilities for various wildlife uses, eg browsing, denning, breeding, migration, etc). What kinds of data fulfill this requirement?

WORKING GROUP DISCUSSION

It is possible to characterize ecoregions by characteristic species; but not by species diversity. It is not likely that intermediate subdivisions such as land systems will be well characterized.

The collective term for the upper end of the hierarchy (eg ecoregion, ecodistrict) is "fauna". Examples are the 'high arctic fauna' characterized by muskox, red phalarope, varying lemming, and polar bear. At the land district level an example is the 'subalpine fauna' characterized by pika, tounsend's warbler, red squirrel, and mountain goat. Land types in the same land system may have quite different communities.

'Characteristic species' are those that have relatively restricted distributions and occur in their greatest densities in a particular area. Communities are often composed of species with either broad or narrow habitat requirements.

Diversity is a poor criterion for identifying the levels of a land classification system because it is a function that depends on both the number of species and the relative abundance of species to each other. Thus, an area with few species may have high diversity if all species occur in approximately the same densities. By contrast, an area with many species has low diversity if there are one or two abundant species and many rare species. Further, diversity ignores important phenomena such as rarity, uniqueness, narrow habitat requirements and "key-industry organisms".

The criteria that should be used are the presence/absence of characteristics species and ecological dominance, or large numbers of particular species.

With respect to the second question, consideration should be restricted to a few key species (ie species of great economic importance; key industry organisms; rare species; species that aggregate in large numbers).

A goal of wildlife inventory is to describe and to explain the distribution of animals in space. To explain wildlife distributions effectively, the ELS team needs:

a) the distribution, depth and duration of snow cover;

b) the distribution of the physiognomic types of vegetation;

c) the distribution and frequency of the various aquatic habitats. Incidentally, there should be more attention to classification of aquatic habitats;

d) the distribution and duration of ice cover types in arctic marine areas. Many arctic marine species select open leads, pressure ridges or polynia in preference to flat unbroken ice;

e) the distribution of key industry organisms (ie prey species that are abundant and that support many other species in a food chain); and,

f) the distribution and frequency of palatable forage species of ungulates.

RECOMMENDATIONS

Criteria such as species diversity should not be used to distinguish animal communities. Animal communities may be characterized by dominant species, characteristic species, relative abundance, and key industry organisms. Single-species criteria should not be used to characterize the various levels of a biophysical classification.

Secondary topic area B: *Wildlife terminology and definitions in the context of ecological land survey.*

Confusion often results from differing interpretations of terms used by different disciplines within the ELS team. The definition of "wildlife" itself is even nebulous (see CCELC Newsletter No. 4). Mapping of wildlife information requires clear, precise and consistent definitions of the factors being mapped. A draft of wildlife terms defined with respect to ELS has been circulated.

1) Should some of these definitions be changed? If so, how?

2) What other terms and definitions have been omitted?

3) Would the working group make a short list of the most important terms that should be clearly defined?

WORKING GROUP DISCUSSION

The working group agreed that a glossary of wildlife terms would be useful to users and other members of the ELS team. It was noted however, that the draft glossary circulated (see Appendix A) is in need of major revisions as many of the definitions lack major and vary

from accepted usage.

Fundamental terms such as cover, niche, niche overlap, trophic level, competition, physiognomy (ie of vegetation) competitive excersion, and resource partitioning should be added.

The following brief list of terms that should be clearly defined in the revised glossary was submitted.

- population
- community
- relative abundance
- density
- diversity (as opposed to the number of species)
- niche
- habitat
- limiting factor
- physiognomy of vegetation
- cover
- aspect
- specialist species, generalist species
- dispersion, dispersal
- trophic level, food chain

RECOMMENDATIONS

If CCELC decides to adopt a uniform glossary of wildlife terminilogy, it is strongly urged that definitions conform to those used in the current ecological literature.

WORKING GROUP D

Ray Schmidt
Pat Flory
Jean Thie
Greg Wickware
Basil Delaney
Kevin Van Tighem

ASSIGNED TOPICS AND QUESTIONS

Primary topic area: *Mapping and presentation of wildlife data in ecological land surveys.*

Mapping and presentation of data in an ecological land survey is critical to the success of the survey. Users are alienated by maps and data presentations that are confusing and awkward to use, or that have apparently complex legends or symbols. Clear and accurate representation of the data in a form understandable and useful to planners and decision makers is a must.

1) Based on experience to date, what are the best ways to present wildlife information?

2) What kinds of wildlife information are best handled with:

   a) maps
   b) legends
   c) text
   d) overlays, etc.

3) Should information on individual species by mapped/presented or should we be mapping or describing animal communities (or groups of related species)?

WORKING GROUP DISCUSSION

The group agreed that wildlife information should be presented on maps accompanied by legends, text, and where needed, overlays. Wildlife maps should be developed from the ecological land survey (ELC) data base; and they should be an evaluation of the ELS data base; and they should accompany that data base.

The specific types of wildlife maps produced should be determined by the user in cooperation with the ELS team. In order to meet particular user needs single purpose or thematic maps (eg single species distribution, capability, population density indices, etc) are considered preferable.

The wildlife map should show patterns of species abundance and distribution. The maps should be designed to be used in conjunction with the ELC data base. A legend should also accompany the map. This legend should clarify ELS/wildlife relationships -- that is, how the land and wildlife components interact. There should be a concise report describing qualatative variations, unique life history features, and community interactions at regional, district, section and site levels. The report is needed to give perspective and discuss inconsistencies. Additional overlays would be optional and could illustrate dynamic phenomena such as: migration patterns, seasonally critical habitats, key vegetation, land use, land tenure, and the like.

RECOMMENDATIONS

1) All wildlife interpretations should be drawn from the ELS data base.

2) Wildlife interpretations should be displayed on single purpose or thematic maps.

WORKING GROUP E

Glen Adams
Gary Ironside
Jean-Louis Bélair
Raymond McNeil
Arnold Boer
Fred Payne

ASSIGNED TOPICS AND QUESTIONS

Primary topic area: *Wildlife terminology and definitions in the context of ecological land survey.*

Confusion often results from differing interpertations of terms used by different disciplines within the ELS team. The definition of "wildlife" itself is even nebulous (see CCELC Newsletter No. 4). Mapping of wildlife information requires clear, precise and consistent definitions of the factors being mapped. A draft of wildlife terms defined with respect to ELS has been circulated.

1) Should some of these definitions be changed? If so, how?

2) What other terms and definitions have been omitted?

3) Would the working group make a short list of the most important terms that should be clearly defined?

WORKING GROUP DISCUSSION

Reviewing the proposed glossary (see Appendix A) the group felt the preparation of such a glossary was a useful project and should be continued. It was noted that the number of terms should be expanded and the existing definitions improved. The group felt that substantive revisions to the glossary within the time allotted for discussion was not practical but did put forward the following recommendations.

RECOMMENDATIONS

1) That the work on the glossary is worthwhile and should be continued. The number of terms defined should be expanded and the existing definitions improved.

2) That a subcommittee be struck to continue this work.

3) That varying interpretations of similar terms used by disciplines should be rationalized.

4) That definitions should reflect original authorities and contain cross references to other glossaries.

SUMMARY RECOMMENDATIONS

1) That ecological land surveys are a suitable format for wildlife evaluations provided that:

    a) the symbology used is consistent;

    b) the definitions used are universally acceptable, precise, and consistent;

    c) the dynamics of animal populations are examined through additional studies.

2) That accelerated baseline studies employ the ELS approach.

3) That the examination of some limiting factors, abiotic factors, etc are beyond the scope of the ELS approach but must be accommodated in the mapping format.

4) That the wildlife biologist must be involved early in the process, throughout the process, and be responsible for the interpretations.

5) That analysis should begin with single species or thematic maps.

6) That the CCELC form a permenent working group on wildlife.

7) That habitat classification guidelines are important and, as no such guidelines exsist, a committee be struck to develop such guidelines.

8) That the CCELC develop and propose that, in conjunction with all jurisdictions a national wildlife habitat mapping series be initiated at an appropriate reconnaisance scale.

SOMMAIRE DES DISCUSSIONS ET DES RECOMMANDATIONS

Cinq groupes de travail ont été constitués au cours de l'après-midi de la première journée de l'atelier. On a confié à ces groupes l'examen de questions découlant des thèmes de discussion suivants:

1) *les données sur la faune en rapport avec les buts du Relevé écologique des terres (RET);*

2) *les rapports entre les écosystèmes des terres et l'habitat de la faune;*

3) *les méthodes de cartographie et de présentation de données sur la faune dans les rapports du RET;*

4) *les données sur la faune, autres que celles importantes pour l'identification et la cartographie des habitats, qui devraient être incorporées à la base de données du RET; et*

5) *l'importance de la terminologie et des définitions relatives à la faune dans le contexte d'un relevé écologique des terres.*

Chaque groupe devait déposer pendant la séance plénière du lendemain, par l'intermédiaire d'un porte-parole, un rapport sur l'un des cinq thèmes de discussion. Chaque groupe devait examiner, en plus du sujet de discussion principal, deux autres questions pour qu'il y ait un certain chevauchement dans les travaux des groupes de travail.

GROUPE DE TRAVAIL A

Wayne Strong*	Bruce Pendergast
Ed Wiken	Jack Millar
Harry Stelfox	Peter Achuff
Roy Jacobson	

SUJET DE DISCUSSION ET QUESTIONS ASSIGNÉES

Principal sujet de discussion: *Quelles sont les données sur la faune en rapport avec les buts du Relevé écologique des terres?*

Les limites et les objectifs de tout RET particulier dictent les types de données à acquérir. C'est pourquoi, nous avons besoin de directives sur les types de données nécessaires à l'intégration efficace des données sur la faune dans le relevé. Par exemple:

1) Quelles sont les données sur la faune qui nous permettront d'élaborer des critères de reconnaissance des niveaux de la classification (écorégion, écodistrict, écosection, etc.)?

2) En plus de nous permettre de déterminer et de classer les écosystèmes des terres dans les divers paliers de généralisation, les données sur les terres doivent aussi servir aux évaluations et interprétations de la faune (c'est-à-dire à déterminer le potentiel d'utilisation des terres par la faune à différentes fins telles que le pâturage, l'habitation, la reproduction, la migration, etc.). Quels types de données répondent à ces exigences?

DISCUSSION DU GROUPE DE TRAVAIL

Le groupe conclut qu'il est difficile de déterminer la façon dont les caractéristiques fauniques peuvent être mises en corrélation avec les divers paliers de la hiérarchie du RET. La difficulté vient en partie du fait que les corrélations varient d'une espèce à une autre.

Le groupe considère que la base de données du RET convient aux évaluations fauniques pourvu qu'on cerne au début des projets les besoins en données du biologiste. Le groupe est d'avis que les données sur la faune devraient être incorporées à la base de données du RET au niveau des espèces et que les espèces étudiées devraient correspondre aux intérêts de l'utilisateur. De plus, il faudrait aussi inclure dans la base de données les informations culturelles (par exemple, les schèmes d'utilisation des terres) qui influent sur la faune et d'autres schèmes.

RECOMMANDATIONS

1) Inclure les données sur la faune dans la base de données du RET au niveau des espèces.

2) Relier les données sur la distribution de la faune aux autres informations (pédologiques, phytologiques, topographiques, climatiques, etc.) de la base de données.

3) Déterminer les données dont ont besoin les biologistes au début du programme de RET.

* Les noms soulignés sont ceux des présidents des groupes de travail.

GROUPE DE TRAVAIL B

Will Holland
Richard Kerr
Bill Prescott
Dennis Demarchi
Phillip Taylor
Ian Corns
Nicholas Novakowski

SUJET DE DISCUSSION ET QUESTIONS ASSIGNÉES

Principal sujet de discussion: *Les relations entre les écosystèmes des terres et l'habitat de la faune.*

Le lien le plus important entre la biologie de la faune et le RET est peut-être la façon dont l'habitat d'une espèce, décrit par le biologiste de la faune, est mis en corrélation avec les écosystèmes des terres cartographiées par l'équipe du RET.

1) D'après votre expérience, de quelles façons la biologie de la faune et le RET sont compatibles?

2) Quelles sont les données que le biologiste de la faune doit transmettre à l'équipe du RET pour s'assurer que les données qu'elle recueille et met sur carte répondent à ses besoins?

Par exemple
- définitions
- critères d'identification des habitats
- échelles des cartes
- données biophysiques

3) En pratique, quels types de données le biologiste devrait-il s'attendre à ce que le reste de l'équipe du RET acquière et mette sur carte?

4) Quand le biologiste devrait-il se joindre à l'équipe du RET: avant ou après la cartographie des écosystèmes des terres? Pourquoi?

DISCUSSION DU GROUPE DE TRAVAIL

Au départ, la définition et l'acceptation des termes habitat et écosystème des terres ont respectivement donné du mal au groupe. Bien que le problèmes n'aient pas été résolus, on a présenté une définition partielle du terme habitat selon laquelle un animal doit ou peut faire partie de l'habitat.

Le groupe estime que l'habitat de la faune est une composante des écosystèmes compatible avec les composantes pédologique et végétale de l'environnement. Il croit que les méthodes utilisées pour l'étude de ces composantes sont aussi compatibles. Par contre, le groupe est d'avis que l'habitat est une composante incompatible avec le sol et la végétation dans le contexte de la cartographie, car différents types de faune exigent différents ensembles d'habitats.

En réponse à la deuxième question, il est clair que la collaboration du biologiste de la faune est nécessaire dans ces domaines. Il semble qu'il sera assez difficile d'obtenir de bonnes définitions précises parce que les biologistes de la faune ne connaissent pas encore toutes leurs exigences. L'expression habitat préféré est jugée importante mais le groupe ne s'y est pas attardé à cause du grand nombre de variables en cause. On propose l'établissement d'une table de diversité qui pourrait être utilisée pour l'évaluation de la qualité de l'environnement. Le groupe est d'avis que les estimations des populations totales des espèces fauniques sont peu utiles parce qu'elles varient beaucoup avec le temps.

Il faut aussi élaborer des critères d'identification des habitats avant d'entreprendre la cartographie.

Les échelles de cartes devraient varier de 1:24 000 pour les pâturages des Etats-Unis à 1:250 000 pour la Collection de documents d'information sur l'utilisation des terres dans le Nord. En général, l'échelle de 1:50 000 est la plus souhaitable, en partie parce qu'elle est compatible avec les cartes du SNRC. On souligne que l'échelle des cartes dépend aussi du type de projet, des besoins de l'usager et du coût.

Les données biophysiques nécessaires à l'évaluation des habitats comprennent les caractéristiques abiotiques et biotiques. Le groupe est d'avis que, dans cette dernière catégorie, la classification de la végétation et certaines indications sur l'abondance des espèces importantes pour la faune sont nécessaires. Il faudrait étudier particulièrement les facteurs sur lesquels il y a peu de documentation; par exemple:

- géologie
- climat
- eau
- profondeur de la neige
- utilisations saisonnières
- aire de dispersion hivernale
- aire de dispersion estivale
- espèces de succession végétale
- intensité de l'utilisation par la faune
- temps de l'évaluation de l'habitat

Le groupe convient que le biologiste peut s'attendre à ce que le reste de l'équipe du RET relève et mette sur carte les données de base descriptives et quantitatives sur la topogra-

graphie, les caractéristiques des sols et de la végétation et les différences climatiques ou zonales supposées d'après l'évolution du sol et de la végétation. On souligne aussi que le reste de l'équipe du RET doit aider le biologiste à interpréter comment les caractéristiques biophysiques déterminées et mises sur carte se combinent pour fournir des qualités environnementales qui influent sur la faune; par exemple:

- les moraines à surface bosselée par rapport aux moraines de surface ou aux plaines lacustres;

- les caractéristiques de la végétation (c'est-à-dire la taille, la forme, la complexité) et;

- la succession végétale, les taux de changement etc.

De plus, pour assurer une meilleure gestion de la faune, les biologistes doivent savoir quels sont les paramètres biologiques pouvant être manipulés et connaître les façons de le faire, quelles sont les modifications qui peuvent être apportées et quelles en sont les conséquences; et qu'est-ce qui doit être préservé et quelles sont les solutions gestionnelles.

Le groupe est d'avis que le biologiste doit se joindre à l'équipe avant le début des travaux de cartographie parce que:

- il peut déterminer les habitats qui sont importants pour ses travaux, y compris les caractéristiques de la topographie, des sols et de la végétation; par exemple, le relief, l'aspect, la texture, le drainage, les types de groupements végétaux etc., et

- sa contribution dès le début réduit les coûts en éliminant la révision et les travaux en double.

RECOMMANDATIONS

Le groupe recommande:

1) Que les biologistes de la faune soient consultés et invités à se joindre aux équipes de cartographie du RET au début de la phase de planification des projets et que leur participation se poursuivre au cours des phases actives de classification et d'évaluation du RET.

2) Que les biologistes de la faune élaborent et fournissent:

   a) des définitions complètes et rigoureuses de leur termilogie,

   b) des critères d'identification des habitats, de préférence sous forme de guide pratique,

   c) une liste des facteurs fauniques sur lesquels il existe peu de documentation mais qui sont nécessaires à l'amélioration de l'évaluation des habitats.

3) Que les membres des équipes du RET aident les biologistes de la faune à interpréter comment les caractéristiques environnementales se combinent pour donner des qualités environnementales qui inflent sur la faune.

4) Que le CCET, en collaboration avec des spécialistes et toutes les autorités, planifie la réalisation d'une série de cartes nationales sur la faune, à l'échelle de 1:250 000, qui comprendrait les buts et objectifs nationaux en matière de faune, permettant l'acquisition de connaissances et, par conséquent, augmentant l'efficacité de la gestion de la faune.

GROUPE DE TRAVAIL C

Don Karasiuk — Geoff Holroyd
Bob Hart — Gerald Townsend
Herman Dirschl — Brent Markham
Ian Sneddon

SUJET DE DISCUSSION ET QUESTIONS ASSIGNÉES

Principal sujet de discussion: *Incorporation des données sur la faune, autres que celles de l'identification et de la cartographie des habitats, dans les relevés écologiques des terres.*

En plus de celles que comportant d'identification, de la cartographie et de la description des habitats fauniques, d'autres données importantes sont nécessaires à la compréhension de l'écologie de la faune.

1) les tailles, densités et déplacements des populations;

2) les variations saisonnières et journalières de certains des facteurs mentionnées ci-dessus et d'autres facteurs;

3) le comportement migratoire;

4) la reproduction.

L'équipe du RET ne peut receuillir beaucoup de ces données durant le temps assez court qu'elle passe sur le terrain. De toute évidence, il faut faire des études additionnelles sur la faune.

1) comments peut-on réaliser une intégration efficace avec le reste des données rassemblées par l'équipe du RET?

2) Jusqu'à quel point peut-on extrapoler pour que les données tirées de la documentation s'appliquent à diverses situations?

DISCUSSION DU GROUPE DE TRAVAIL

Le groupe n'est pas d'accord avec l'introduction de cette question étant donnée les objectifs de l'inventaire de la faune qui sont de:

1) déterminer la distribution spatiale des espèces, des populations et des individus;
2) déterminer la taille et la densité de populations; et
3) déterminer la distribution saisonnière des espèces.

Toutefois, le groupe admet que la dynamique des populations, la reproduction, les mouvements périodiques et le comportement migratoire dépassent probablement le cadre d'un inventaire de la faune.

L'INTEGRATION AVEC L'EQUIPE DU RET

Une intégration efficace avec le reste de l'équipe du RET est possible si la composante faunique accepte le même ordre de types et de systèmes des terres que la composante sol-végétation-topographie. Cependant, le biologiste de la faune doit faire partie intégrante de l'équipe du RET, c'est-à-dire que son opinion quant aux sols et à la végétation doit avoir autant de poids que celle des autres pour la détermination des critères à mettre sur carte. Des critères comme la profondeur de la neige, l'aspect, les "plaques" de végétation et la proximité de terrains d'évasion sont très importants pour la détermination de la distribution des ongulés mais sont rarement mis sur carte dans les études biophysiques. De plus, les cartes des études biophysiques devraient indiquer la végétation réelle et non la végétation possible.

Tous les aspects des études du RET auront plus d'efficacité si les objectifs de l'utilisateur ne devrait pas être confondus par des légendes compliquées et une masse de détails techniques. Il faudrait lui présenter des cartes thématiques sous forme de rapport final. C'est le biologiste, et non l'utilisateur, qui devrait faire l'interprétation des données du relevé. Grâce aux carte thématiques, il n'est plus nécessaire d'expliquer la non-concordance entre les données sur la faune et les autres données du RET; les aires "exceptionnelles" sont simplement évaluées en conséquence sur les cartes thématiques.

Les données sur la faune devraient être incluses dans l'évaluation finale des données et dans le rapport définitif. Cependant, l'utilisation de la faune comme telle n'est pas un critère suffisant pour faire la distinction entre les différents types de terre. La chasse, les schèmes classiques d'utilisation de la faune et les extinctions locales sont des empêchements.

La légende pour la faune devrait ressembler autant que possible à celles pour les sols, la végétation et la topographie.

EXTRAPOLATION SUR LA DOCUMENTATION.

Il existe deux types principaux d'études sur la faune aux fins de notre propos. Pour l'étude de type classique, on choisit une

grille, une zone d'étude ou un quadrat réduit que l'on étudie intensivement. Ces études sont souvent d'une grande rigueur scientifique (validité interne) mais nous ne savons pas jusqu'à quel point les résultats sont représentatifs de l'ensemble des habitats. Par contre, les inventaires de la faune contiennent souvent moins de détails sur la fonction ou la structure des populations mais nous savons jusqu'à quel point les résultats sont représentatifs de l'ensemble des habitats.

Il arrive souvent que les données tirées de la documentation ne puissent être extrapolées pour s'appliquer à des aires importantes parce que:

1) l'aire d'étude était typique, ayant des densités de population exceptionnellement élevée ou un nombre d'espèces exceptionnellement important;

2) le scientifique n'a pas donné assez de détails dans la description de son aire d'étude;

3) les diverses parties de l'aire d'étude ont été étudiées de façon inégale;

4) les exigences en matière d'habitat des espèces étudiées étaient spécialialisées ou mal connues;

Le mieux serait qu'un inventaire de la faune soit fait avant les études détaillées des populations. L'inventaire du RET peut servir aux études détaillées subséquentes en:

1) déterminant les montants à consacrer aux différents types d'habitat. Le fait de choisir des aires d'étude uniques est peu valable parce que les résultats ont peu de valeur pour l'ensemble des habitats;

2) les études du RET augmentent l'exactitude provisionnelle des études classiques en indiquant à quelle proportion d'une région les résultats s'appliquent;

3) les études du RET fournissent au planificateur un ensemble unitaire qui lui permet de faire des compromis entre des utilisations concurrentes des terres;

4) le RET aide à la conception d'un échantillonnage et à la stratification des données dans les analyses statistiques;

5) le RET permet le calcul des populations régionales pourvu que tous les types d'habitat aient été échantillonnés.

RECOMMANDATIONS

1) Il faudrait considérer les points suivants comme des éléments indispensables d'un inventaire biophysique de la faune;

a) description de la distribution de la faune et de sa quantité dans un espace géographique;

b) description de la distribution de la faune et de sa quantité par rapport au sol, à la végétation, au climat et aux formes de terrain;

c) distribution possible de la faune et de sa quantité (potentiel ou capacité de charge), relativement au sol, à la végétation, au climat et à la topographie.

2) L'assemblée devrait reconnaître que l'étude des relations fonctionnelles entre les membres des collectivités animales (interactions de concurrence, relations prédateur-proie, mortalité, natalité et survie) dépassent les limites de l'inventaire biophysique de la faune.

3) L'opinion du biologiste de la faune devrait être jugée aussi importante que celle des autres membres de l'équipe du RET pour la détermination des critères qui seront mis sur carte et de la hiérarchie de la classification des terres.

4) La végétation réelle, non pas la végétation possible, est un important facteur déterminant de la distribution de la faune; par conséquent, on conseille fortement aux équipes du RET de mettre sur la carte la végétation réelle.

5) Les variations dans la distribution, les quantités et les utilisations de la faune ne devraient pas servir de critères pour différencier les divers types de terre.

6) Le biologiste qui entreprend un inventaire de la faune devrait faire tout son possible pour comprendre les besoins de l'utilisateur, et devrait présenter ses données sous la forme qui conviendrait le mieux à ce dernier. On recommande fortement l'utilisation de cartes thématiques, à but unique.

7) L'inventaire de la faune, de concert avec le relevés du RET, devrait précéder les études fonctionnelles détaillées (dynamique des populations, études prédateurs-proies) dans la formulation des plans de gestions de la faune.

En outre, le groupe de travail a examiné les duex sujets secondaires, comme suit.

Thème secondaire A : *Quelles sont les données sur la faune en rapport avec les buts du relevé écologique du territoire?*

Les limites et les objectives de tout RET particulier dictent les types de données à acquérir. C'est pourquoi, nous avons besoin de directives sur les types de données nécessaires à l'intégration efficace des données sur la faune dans le relevé. Par exemple:

1) Quelles sont les données sur la faune qui nous permettront d'élaborer des critères de reconnaissance des niveaux de la classification (écorégion, écodistrict, écosection, etc.)?

2) En plus de nous permettre de déterminer et de classer les écosystèmes des terres, dans les divers paliers de généralisation, les données sur les terres doivent aussi servir aux évaluations et interprétations de la faune (c'est-à-dire à déterminer le potentiel d'utilisation des terres par la faune à différentes fins telles que le pâturage, l'habitation, la reproduction, la migration, etc.). Quels types de données répondent à ces exigences?

DISCUSSION DU GROUPE DE TRAVAIL

Il est possible d'étiqueter des écorégions d'après des espèces caractéristiques, mais non d'après la diversité des espèces. Il ne semble pas que l'on puisse bien caractériser des subdivisions intermédiaires comme les systèmes de terres.

La faunce est le "dénominateur commun" du sommet de la hiérarchie (c'est-à-dire de l'écorégion et de l'écodistrict). Par exemple, "la faune du haut arctique": le boeuf musqué, le phalarope roux, le lemming variable et l'ours blanc. Au niveau de l'écodistrict, il y a, par exemple, la "faune subalpine": on pense au pica, à la fauvette de Townsend, à l'écureuil roux et à la chèvre de montagne. Les types de terres apparenant au même système peuvent avoir des communautés assez différentes.

Les "espèces caractéristiques" sont celles dont l'aire de distribution est relativement limitée et dont le plus grand nombre d'individus se trouvent dans une région donnée. Les communautés se composent souvent d'espèces dont l'habitat doit, dans certains cas, offrir des ressources précises, dans d'autres, non.

On peut difficilement se fonder sur la diversité pour déterminer les niveaux d'un système de classification du territoire, parce qu'il s'agit d'un élément qui dépend à la fois du nombre d'espèces et de leur abondance relative. Ainsi, une région peut comprendre peu d'espèces et avoir une grande diversité, si toutes les espèces y ont à peu près la même densité. Par contre, il peut y avoir, dans une région, un grand nombre d'espèces et une faible diversité, si une ou deux espèces sont abondantes et les autres, rares. Par ailleurs, la notion de diversité ne tient pas compte d'importants facteurs comme la rareté, l'unicité, les exigences très précises en matière d'habitat et les "organisme clé".

Les critères qui devraient entrer en jeu sont la présence ou l'absence d'espèces caractéristiques et la dominance écologique, c'est-à-dire les espèces que l'on trouve en grands nombres.

En ce qui concerne la deuxième question, il serait bon que l'on ne s'attache qu'à un petit nombre d'espèces-clé (c'est-à-dire les espèces ayant une grande valeur qui se réunissent en grands nombres).

L'inventaire de la faune a, entre autres, l'objectif de décrire et d'expliquer la distribution des animaux dans l'espace. A cette fin, l'équipe chargée du relevé écologique du territoire doit connaître:•

a) la distribution, l'épaisseur et la durée de la neige;

b) la distribution des types de la physionomie de la végétation;

c) la distribution et la fréquence des divers habitats aquatiques (on devrait d'ailleurs étudier davantage la classification des habitats aquatiques);

d) la distribution et la durée des types de couvertures de glace dans les régions marines de l'Arctique. Un grand nombre d'espèces marines préfèrent les chenaux, les crêtes de glace ou les polynies aux étendues de glace intacte;

e) la distribution des organisme-clé (c'est-à-dire les proies abondantes situées sous de nombreuses autres espèces dans une chaîne alimentaire); et

f) la distribution et la fréquence des espèces d'ongulés qui se nourrissent de fourrage appétible.

RECOMMANDATIONS

Des critères comme la diversité des espèces ne devraient pas servir à distinguer les communautés animales. Ces dernières peuvent être caractérisées par l'espèce dominante, l'espèce typique, l'abondance relative et les organismes clés de la écosysteme. Les critères d'une seule espèce ne devraient pas servir à caractériser les divers niveaux d'une classification biophysique.

Thème secondaire B: *La terminologie de la faune et les définitions dans le cadre du relevé écologique du territoire.*

Il y a souvent confusion à cause des diverses interprétations des termes utilisés dans différentes disciplines au sein de l'équipe du RET. Même la définition du terme "faune" n'est pas claire (voir Bulletin CCCET N° 4). La cartographie des données sur la faune nécessite des définitions claires, précises et constantes des facteurs mis sur carte. On distribue une liste provisoire de termes relatifs à la faune définis par rapport au RET.

1) Faudrait-til changer certaines de ces définitions? si oui, comment?

2) Quels qutres termes et définitions ont été oubliés?

3) Le groupe de travail pourrait-il dresser une courte liste des termes les plus importants qu'il faudrait clairement définir?

DISCUSSION DU GROUPE DE TRAVAIL

Le groupe de travail convient qu'un glossaire des termes relatifs à fa faune serait utile aux usagers et aux autres membres de l'équipe du RET. Cependant, on fait remarquer que le glossaire provisoire distribué (voir annexe A) a besoin d'importantes modifications car de nombreuses définitions manquent de rigueur et diffèrent de l'usage accepté.

Il faudrait ajouter des termes fondamentaux tels que: couvert, niche, chevauchement de niches, niveau trophique, compétition, exclusion due à la compétition physionomique (c'est-à-dire des végétaux) et partage des ressources.

On a présenté une courte liste des termes à définir clairement dans le glossaire:

- population
- community
- relative abundance
- density
- diversity (par opposition au nombre d'espèces)
- niche
- habitat
- limiting factor
- physiognomy of vegetation
- cover
- aspect
- specialist species, generalist species
- disperson, dispersal
- trophic level, food chain

RECOMMANDATIONS

Si le CCET décide d'adopter un glossaire uniforme des termes relatifs à la faune, il est fortement conseillé que les définitions correspondent à celles utilisées dans la documentation écologique actuelle.

GROUPE DE TRAVAIL D

Ray Schmidt
Pat Flory
Jean Thie
Greg Wickware
Basil Delaney
Kevin Van Tighem

SUJET DE DISCUSSION ET QUESTIONS ASSIGNÉES

Principal sujet de discussion: *cartographie et présentation des données sur la faune dans les relevés écologiques des terres.*

La cartographie et la présentation des données dans un relevé écologique des terres sont d'une importance capitale pour la réussite du relevé. Les utilisateurs sont gênés par des cartes et des présentations de données qui prêtent à confusion et sont difficiles à utiliser ou dont les légendes ou symboles semblent complexes. Il faut une représentation claire et exacte des données sous une forme compréhensible et utile aux planificateurs et aux décisionnaires.

1) D'après votre expérience, quelles sont les meilleures façons de présenter des données sur la faune?

2) Quels types de données sur la faune sont le mieux traités au moyen de:

   a) cartes
   b) légendes
   c) textes
   d) calques de superposition, etc.

3) Est-ce que les données sur les espèces individuelles devraient être mises sur cartes/présentées ou est-ce qu'il faudrait mettre sur carte ou décrire les collectivités animales (ou groupes d'espèces connexes)?

DISCUSSION DU GROUPE DE TRAVAIL

Le groupe convient que les données sur la faune devraient être présentées sur des cartes accompagnées de légendes, de textes et, au besoin, de calques de superposition. Les cartes devraient être tracées à partir de la base de données de la classification écologique des terres (CET); elles devraient être une évaluation de la base de données de la CET et accompagner cette dernière.

L'utilisateur, en coopération avec l'équipe du RET, devrait déterminer quels types précis de cartes sur la faune doivent être établies. Sont préférables les cartes à but unique ou les cartes thématiques (par exemple, la distribution d'une seule espèce, les potentiels, les indices de densité des populations, etc.) pour répondre aux besoins

Les cartes fauniques devraient indiquer les schèmes d'abondance et de distribution des espèces. Il faudrait concevoir les cartes pour les utiliser avec la base de données de la CET. Il faudrait aussi joindre aux cartes une légende qui servirait à éclaircir les rapports entre la CET et la faune; c'est-a-dire, la façon dont les composantes des terres et de la faune agissent les unes sur les autres. Il devrait y avoir un court rapport décrivant les variations qualitatives, les caractéristiques uniques du cycle évolutif, et les interactions des collectivités aux échelons des régions, des districts, des sections et des emplacements. Le rapport est nécessaire car il sert à indiquer la perspective et permet l'examen des contradictions. Les calques de superposition additionnels seraient facultatifs et serviraient à illustrer des phénomènes dynamiques comme: les schèmes migratoires, les habitats critiques suivant les saisons, la végétation principale, l'utilisation des terres, le mode d'occupation, etc.

RECOMMANDATIONS

1) Toutes les interprétations de la faune devraient se fonder sur la base de données de la CET.

2) Les interprétations de la faune devraient être mises sur cartes à but unique ou sur cartes thématiques.

GROUPE DE TRAVAIL E

Glen Adams
Gary Ironside
Jean-Louis Bélair
Raymond McNeil
Arnold Boer
Fred Payne

SUJET DE DISCUSSION ET QUESTIONS ASSIGNÉES

Principal sujet de discussion: *la terminologie et les définitions relatives à la faune dans le contexte d'un relevé écologique des terres.*

Les divergences d'interprétation de termes selon différentes disciplines au sein de l'équipe du RET sont souvent des causes de confusion. Même la définition du terme faune est imprécise (voir le Bulletin N^{o}4 du CCCET).

La cartographie de données sur la faune nécessite des définitions claires, précises et uniformes des facteurs en cause. On a distribué une ébauche de définitions de termes sur la faune en rapport avec le RET.

1) Devrait-on changer certaines de ces définitions? Dans l'affirmative, comment?

2) Quels termes et définitions a-t-on oubliés?

3) Est-ce que le groupe de travail doit dresser une courte liste des termes les plus importants qui devraient être clairement définis?

DISCUSSION DU GROUPE DE TRAVAIL

En examinant le glossaire proposé (Appendice A) le groupe a vu que la rédaction d'un tel glossaire était un travail utile qui vaut la peine d'être continué. Le nombre de termes aurait avantage a être améliorées. Le groupe a jugé qu'il n'était pas practique de faire en profondeur du glossaire vu les limites de temps disponible; il a toutefois fait les recommandations suivantes.

RECOMMANDATIONS

1) Le glossaire est valable, et le tavail devrait être poursuivi. Le nombre de termes qu'il contient devrait être augmenté, et les définitions actuelles devraient être améliorées.

2) Un sous-comité devrait être créé pour s'occuper de la continuation de ce travail.

3) Les différentes interprétations de termes semblables utilisées dans plusieurs disciplines devraient être rationalisées.

4) Les définitions devraient s'en tenir au sujet et renvoyer a d'autres glossaires.

SOMMAIRE DES RECOMMANDATIONS

1) Les relevés écologiques des terres conviennent à l'évaluation de la faune pourvu que:

   a) le symbolique soit uniforme;

   b) les définitions utilisées soient universellement acceptables, précises et uniformes, et

   c) la dynamique des populations animales soit examinée au moyen d'études supplémentaires.

2) Les études de base accélérées devraient utiliser la ligne de conduite du RET.

3) L'examen de certains facteurs limitatifs, abiotiques, etc. se fait en dehors des limites du RET; toutefois, ces facteurs devraient être inclus sur les cartes.

4) Le biologiste de la faune devrait participer au processus dès le début et tout au long de ce dernier, et se charger de l'interprétation.

5) Les analyses devraient commencer par des cartes ne visant qu'une espèce ou par des cartes thématiques.

6) Le CCCET devrait former un groupe de travail permanent sur la faune.

7) Les directives sur la classification des habitats sont importantes; étant donné que de telles directives n'existent pas, il faudrait charger un sous-comité d'en formuler.

8) Le CCCET devrait préparer et proposer la mise en oeuvre, en collaboration avec toutes les autorités, d'une série nationale de cartes sur les habitats fauniques à une échelle de reconnaissance appropriée.

APPENDICES

GLOSSARY OF WILDLIFE-RELATED TERMS USED IN ECOLOGICAL LAND SURVEYS — PRELIMINARY DRAFT

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INTRODUCTION

This glossary contains wildlife terms and wildlife-related terms which commonly occur in Ecological Land Survey reports and maps. These definitions are intended to assist persons providing wildlife input into Ecological Land Surveys (wildlife biologists) as well as persons needing to understand the wildlife information (the users of ELS information). Meanings which are not related to wildlife (eg those which apply only to domestic animals or to vegetation) have been omitted.

Ecological Land Surveys are centred around mapping, describing, and evaluating land as ecosystems (Land Ecosystems) for various levels of generalization of the Ecological Land Classification hierarchy. To be compatible with Ecological Land Surveys, wildlife information must pertain to these Land Ecosystems. As such, many of the following definitions (eg Carrying Capacity and Characteristic Species) reflect this need.

Words which are underlined have been defined elsewhere in the glossary.

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AERIE
See Eyrie.

AVIFAUNA
A collective term referring to all the kinds of birds in an area.

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BEHAVIOUR
Any action of an animal or a population which results from a response to a stimulus or is governed by an inherited instinct.

BIRD SANCTUARY
A Sanctuary established for the preservation and protection of birds.

BREED
To produce offspring by Gestation (mammals) or hatching (most other animals).

BREEDING
The act or process of bearing or generating offspring (calving, nesting, spawning, whelping, etc). The term "breeding" may include the sense of Mating.

BREEDING GROUND
An area of land and/or water used by a species for producing offspring. Breeding grounds represent Critical habitat for some species or populations.

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CALF
The young of most Ungulates and whales.

CALVING
The act of producing a Calf.

CALVING GROUND
An area of land on which the young of an ungulate Population are traditionally born. Calving grounds may represent Critical habitats for populations.

CAPABILITY
See Land capability.

CARNIVORE
An animal in the Order Carnivora (wolves, bears, foxes, etc).

CARRYING CAPACITY
The maximum number of a species which a Land ecosystem will support through the most critical period of the year.

CASUAL SPECIES
A species which occurs rarely or without regularity in a Land ecosystem.

CAVE
A subterranean chamber, usually natural, with an entrance from the surface.

CENSUS -- WILDLIFE
An enumeration of a wildlife Population(s) through direct counts of individuals, estimates using various sampling techniques, or population indices.

CHARACTERISTIC SPECIES
A species commonly occurring in a particular Land ecosystem or Habitat type.

COLONY
A group of individuals of one or more species which live in an area relatively permanently (eg some rodent species) or the historic nesting place of birds (eg cliffs and islands) used by species which associate closely with their own kind during these times.

COMMUNITY
An assemblage of animals or plants which forms a distinct ecological unit; more than one species may be included in a community (see also Population).

CONCENTRATION AREA
An area of much higher than average density within the area of Distribution of a species. This is often a seasonal occurrence (eg caribou calving grounds and waterfowl staging areas).

CONSERVATION
Management of population numbers to prevent depletion (see also Maximum sustainable yield).

CRITICAL AREA
An often broad area of land encompassing Critical habitat(s) for a species or for a major population of a species. For a caribou herd, for example, a critical area may include calving grounds, post-calving grounds, and nearby summer ranges. For other species, a critical area may include numerous scattered critical denning, nesting, etc habitats. Critical areas may also extend well beyond the area actually used by a species (ie to include the area from which indirect effects such as noise, erosion, flooding, etc may be a problem).

CRITICAL HABITAT
See Habitat -- critical.

CYCLE
A complete repetition or iteration of a function (eg breeding) or of a population change which occurs regularly and in a similar (but not always identical) manner each time.

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DEN
A chamber or assemblage of chambers used by mammals for a variety of functions (eg whelping shelter, over-wintering, food storage, and resting).

DENNING AREA
An area containing active and/or inactive Dens. As sites suitable for dens are limited or rare in most areas, denning areas for some species may represent Critical habitat.

DENSITY
The number of individuals of a species per unit area in a Land ecosystem.

DISTRIBUTION
The extent of the geographic area (continuous or discontinuous) over which a species occurs at any time (see also Pattern of occurrence).

DIVERSITY
The number of different wildlife species occurring in a Land ecosystem.

DIVERSITY INDEX
The ratio between the total number of wildlife species in a Land ecosystem and some rating of the relative importance (numbers, biomass, etc) of individual species.

DOMINANCE -- ECOLOGICAL
The condition in which one or more species, by means of their number, coverage, size, or behaviour have considerable influence or control upon the conditions of existence of other species.

DOMINANT (SPECIES)
A species which manifests Ecological dominance.

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ECOLOGICAL DOMINANCE
See Dominance -- ecological.

ECOLOGICAL LAND CLASSIFICATION
The second of the three phases of an Ecological Land Survey. It consists of prefield preparation (planning field work, review of existing data bases, selection of field team, pretyping boundaries of Land ecosystems, etc), field investigations (field data collections), and postfield activities (data analysis and synthesis, organization of the results, and finalization of the ecological classification).

ECOLOGICAL LAND EVALUATION
This is the third and final phase of an Ecological Land Survey. It consists of the preparation of suitable interpretations (for

themes such as land capability, environmental impact, flood prone areas, ecosystem resilience, etc), the development of ecologically based plans, the formulation of appropriate management actions for land use, and the identification of land use conflicts.

ECOLOGICAL LAND SURVEY
An integrated, interdisciplinary approach to surveying land as ecosystems (Land ecosystems). As a process, an Ecological Land Survey has three main phases: 1) Survey Proposal; 2) Ecological Land Classification; and 3) Ecological Land Evaluation.

ECOSYSTEM
A general term for a variety of systems, including animal ecosystem, plant ecosystem, aquatic ecosystem, terrestrial ecosystem, and Land ecosystem.

ENDANGERED
Refers to a species in danger of extinction from any cause (see also Rare and Threatened).

ENDEMIC
Refers to a species which originally occurs only in a given area.

EYRIE
The nest of a Raptor (usually refers to only cliff nest sites).

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FAUNA
A collective term encompassing all the kinds of animal life in an area.

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GAME
Wildlife species hunted for sport or food.

GAME PRESERVE
See Game sanctuary.

GAME RESERVE.
See Game sanctuary.

GAME SANCTUARY
Sanctuary established for the preservation and protection of Game species.

GESTATION
The carrying of young (embryo and fetus) in the uterus -- the breeding mechanism of mammals.

GESTATION PERIOD
The period of time that the embryo and fetus are in the uterus of a mammal.

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HABITAT
The total of environmental conditions of an area occupied by a species for any purpose, at any time of year, and for any duration.

HABITAT -- CRITICAL
Refers to a Habitat which is necessary for the survival of a species in an area (the function served of this habitat cannot be accomplished in an alternate habitat); alteration or destruction of this habitat could lead to decimation of the species or significant reductions in population over a much greater area.

HABITAT -- FUNCTION
Refers to the purpose(s) served, in the life cycle of a species, by a particular Habitat. Habitat functions include: Breeding, denning, feeding (seasonal or year-round), moulting, over-wintering, shelter, staging, and young-rearing.

HABITAT --IMPORTANT
Refers to a Habitat which is regularly occupied by a species under normal conditions. Alteration or destruction of this habitat could lead to changes in population prosperity and behaviour.

HABITAT NEEDS
Refers to various requirements for survival and prosperity of a species which must be met by the Habitat. These include food, water, shelter, suitable breeding and denning sites, etc (see also Habitat function).

HABITAT PREFERENCE
See Habitat -- preferred.

HABITAT -- PREFERRED
Refers to Habitats for which species have a natural inclination over other and often similar habitats within the same general area (eg beaver have a natural inclination for utilizing stands of Populus spp even though stands of other tree species may be present and, in many cases, better situated for use). The biological or traditional reason for the preference is often unknown.

HABITAT TYPE
The kind of habitat which exists in an area based on the dominant vegetation (eg tundra; grassland; coniferous, deciduous, or mixed forest; etc).

HERD (n)
A gathering of gregarious wild animals.

HERD (vb)
To assemble or move in a Herd.

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IMPORTANT HABITAT
See Habitat -- important.

INDICATOR
A plant or animal species which indicates the presence of certain environmental types or conditions.

INTRODUCED SPECIES
See Species -- introduced.

INVENTORY -- HABITAT
A list of Habitats and Habitat types and associated species in a Land ecosystem or in a Study area.

INVENTORY -- WILDLIFE
A list of wildlife species occurring at any time in a Land ecosystem or in a Study area. A wildlife inventory usually includes comments on relative abundance.

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LAND CAPABILITY (for wildlife)
The inherent ability of a Land ecosystem to support the production of Wildlife.

LAND CAPABILITY CLASS (for wildlife)
One of a number of classes which indicate the degree of inherent ability of a Land ecosystem to support the production of wildlife.

LAND CAPABILITY CLASSIFICATION (for wildlife)
A hierarchical arrangement of Land ecosystems into categories according to established criteria as to their inherent ability to support the production of wildlife. An example classification system is the Canada Land Inventory "Land Capability for Wildlife -- Ungulates (or Waterfowl)." In this system, classes range from (1), for lands which "have no significant limitations to the production of ungulates (or waterfowl)," to (7), for lands which "have limitations so severe that there is no ungulate (or waterfowl) production."

LAND ECOSYSTEM
Refers to any ecologically defined unit of land identified for any hierarchical level of an Ecological Land Classification system (Ecoprovince, Ecoregion, Ecodistrict, Ecosection, Ecosite, and Ecoelement).

LIFE-FORM
The characteristic form or appearance of a plant species at maturity (eg tree, shrub, herb, etc).

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MANAGEMENT
The manipulation of the biological and/or physical parameters of an area to attain certain goals (eg increased waterfowl productivity).

MAP
A representation, usually on a flat surface, of a geographical area of land.

MAPPING
The act of representing on a Map biological and physical characteristics related to a Study area in general or to integrated units such as Land ecosystems within it.

MATE (n)
Either member of a breeding pair of animals.

MATE (vb)
To join together as Mates for the purpose of producing offspring.

MATING
The act of joining together as Mates for the purpose of producing offspring. Mating may be for the remainder of the lives of the animals concerned or it may be transitory; some animals may have more than one mate.

MAXIMUM SUSTAINABLE YIELD (MSY)
The maximum number of animals which may be harvested without initiating a long-term decline in population numbers.

MIGRATION
The periodic movement of a population or part of it from one geographic area to another.

MIGRATION ROUTE
Refers to a line of travel of animals between Habitats or Ranges. For many populations, specific migration routes have been traditionally used for hundreds or thousands of years, and the routes therefore represent Critical habitats; alterations to an area can potentially disrupt migration along these routes, threatening the population.

MIGRATORY
Refers to species which regularly move from one place to another and back to the approximate starting area.

MINERAL LICK
Area containing sought-after mineral salts; ungulates often congregate at mineral licks.

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NATIVE SPECIES
See Species -- native.

NATURAL OCCURRENCE
See Distribution.

NON-RENEWABLE RESOURCE
Any Resource which cannot regenerate if it is reduced.

OCCURRENCE
Refers to the presence of a species within a Land ecosystem, regardless of the reason for the presence or the duration (see also Pattern of occurrence and Distribution).

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PASSERINE
Referring to perching birds (Order Passeriformes).

PATTERN OF OCCURRENCE
The distribution of individuals of a species within a Land ecosystem.

POPULATION
A group or groups of interacting individuals of the same species in a common spatial arrangement (includes herd, colony, and flock).

POPULATION CYCLE
See Cycle.

POPULATION DENSITY
See Density.

POPULATION DYNAMICS
The numerical changes in a population which occur within a stated period of time.

POST-CALVING GROUND
The area through which an ungulate Population travels during the first few days after the annual calving period on traditional Calving grounds. Because of the susceptibility of calves to a variety of factors (eg disturbance by man may lead to separation of calves from cows when the calves are too young to survive independently), a post-calving ground represents Critical habitat for an ungulate population (eg a caribou herd).

POTENTIAL (for Production)
See Land capability.

PREDATION
The act of an animal (usually a Predator) killing another animal.

PREDATOR
An animal which kills other animals, usually for food.

PREDATORY
Refers to an animal which kills other animals.

PRESERVE
An area managed for the protection of biological and/or physical Resources.

PREY
An animal species which is hunted and killed by other animals (Predators).

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RANGE
The geographic extent over which an animal or population may be found.

RANGE -- HOME
The area which is traversed by an animal in its day-to-day activities and is generally marked or defended (usually against others of the same species).

RANGE -- SUMMER
The area in which an animal or Population occurs during the summer months.

RANGE -- WINTER
The area in which an animal or Population occurs during the winter months.

RAPTOR
A predatory bird which has feet with curved, sharp claws and a beak adapted for seizing Prey. "Raptor" usually refers to daytime species as opposed to nocturnal species such as owls.

RARE
Refers to a species which occurs in very low numbers throughout its area of Distribution but which is presently in little danger of extinction (see also Endangered and Threatened).

RENEWABLE RESOURCE
Any Resource which can naturally replace its numbers.

RESIDENT SPECIES
A species which remains year-round in an area.

RESILIENCE -- HABITAT
Refers to the ability of a Habitat to recover from or adjust easily to changes to any of its biological or physical components.

RESILIENCE -- SPECIES
Refers to the ability of a species to recover from or adjust easily to changes in any aspect(s) of its existence.

RESOURCE
Any biological or physical parameter of an area which is useful to Man or wildlife for any purpose (see also Renewable resource and Non-renewable resource).

RIPARIAN
Refers to land bordering a stream, lake, or tidewater.

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SALT LICK
See Mineral lick.

SANCTUARY
An area set aside under act or regulation for the preservation and protection of Wildlife. Hunting, trapping, and other activities which may be deleterious to wildlife are prohibited.

SEABIRD
A bird which frequents the open sea (eg albatrosses, fulmars, shearwaters, petrels, gannets, cormorants, jaegers, gulls, murres, guillemots, and puffins).

SENSITIVITY -- HABITAT
Refers to the degree of susceptibility of a Habitat to change resulting from external stimuli such as various uses by man (resource harvesting, recreation activities, pollution, transportation, etc). Sensitivity may be reflected by permanent or temporary, changes to the biological and/or physical components of the habitats.

SENSITIVITY -- SPECIES
Refers to the degree of susceptibility of a species to external stimuli such as noise, pollution, pressures of hunting or predation, presence of roads, power lines, and other man-made features of an area, and alteration or destruction of Habitat components. Sensitivity may be reflected by alterations to the Behaviour of individuals, or populations, or by changes in the Population dynamics.

SHOREBIRD
Any bird of the Order Charadriiformes which frequents the shores of the oceans, lakes, and rivers (especially snipes, plovers, sandpipers, turnstones, and phalaropes).

SPAWN
The eggs of fishes, frogs, oysters, and other aquatic animals.

SPAWNING
The act or process whereby aquatic animals produce or deposit eggs.

SPECIES DIVERSITY
See Diversity.

SPECIES DIVERSITY INDEX
See Diversity index.

SPECIES -- INTRODUCED
A species which is not Native to an area; animals occur there because man has intentionally or accidently introduced individuals to the area and the species has become Naturalized (see also Species -- native and Species -- naturalized).

SPECIES -- NATIVE
A species which occurs naturally within a geographical area (see also Species -- introduced and Species -- naturalized).

SPECIES -- NATURALIZED
A species which is not Native to an area but which is established as if it were a Native species (see also Species -- introduced and Species -- native).

STAGING AREA
An area where animals congregate prior to Migration. For some Waterfowl species and for caribou, tens of thousands or hundreds of thousands of animals may be concentrated in an area of just a few square kilometres; as such, many staging areas represent Critical habitats.

STUDY AREA
The total geographical area of land, usually without an ecologically defined boundary, which is studied to obtain wildlife information.

SUCCESSION -- WILDLIFE
The natural replacement over time of one Community type by another kind. Wildlife successions are related to changes in Habitat, such as vegetation succession, farming, alterations to hydrologic regime, topography, etc, and presence of man and his facilities (roads, power lines, pipelines, dams, dwellings, etc).

SURVEY PROPOSAL
The first of the three phases of an Ecological Land Survey. This phase consists of the identification of study objectives (user needs, work to be done, desired end-product, an assessment of mandate for work, etc) and the setting of the terms of reference (time, money, and human resource constraints, goals, scope, general approach, selection of a team leader, etc).

SURVEY -- WILDLIFE
A comprehensive examination of the wildlife which occur in a Land ecosystem or in a Study area. The survey includes literature review, delineation of Habitat types, field sampling and observation, data analysis, and final integration of wildlife data information into the Ecological Land Classification and the Ecological Land Evaluation.

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TERRITORY
The area which an animal defends against intruders (usually other animals of the same species).

THREATENED
Refers to any species which is likely to become an Endangered species throughout all or a significant portion of its Distribution if populations decline through mortality (harvesting, predation, etc) or through loss of Habitat (see also Endangered and Rare).

TRANSIENT SPECIES
Species whose Occurrence in an area is due solely to Migration between seasonal Ranges. The species may be feeding, resting, or seeking shelter along the Migration route.

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UNGULATE
A mammal with hooves, (caribou, deer, moose, musk-ox, etc.).

UPLAND GAME BIRDS
Game bird species whose habitats are totally terrestrial.

* * * * *

WATERFOWL
Birds of the Order Anseriformes (ducks, geese, swans, and mergansers).

WETLAND
An area which is permanently or intermittently water-covered or has soils which are permanently saturated or nearly saturated due to a lack of natural drainage.

WHELP (n)
One of the young of various Carnivores.

WHELP (vb)
To give birth to -- used with reference to various Carnivores.

WILDFOWL
Non-domesticated gallinaceous birds (Order Galliformes), including grouse, ptarmigan, partridges, and pheasants. "Wildfowl" is sometimes also used to include Waterfowl.

WILDLIFE
Collectively the non-domesticated Fauna. "Wildlife" usually refers to vertebrates only, and fish are normally excluded; however, it may include fish and any invertebrates of subjective interest.

WILDLIFE SURVEY
See Survey -- wildlife.

WILDLIFE CENSUS
See Census -- wildlife.

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YARD
A locality where deer herd in winter.

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